BACON

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PROFESSOR OF MORAL PHILOSOPHY, UNIVERSITY OF ST ANDREWS

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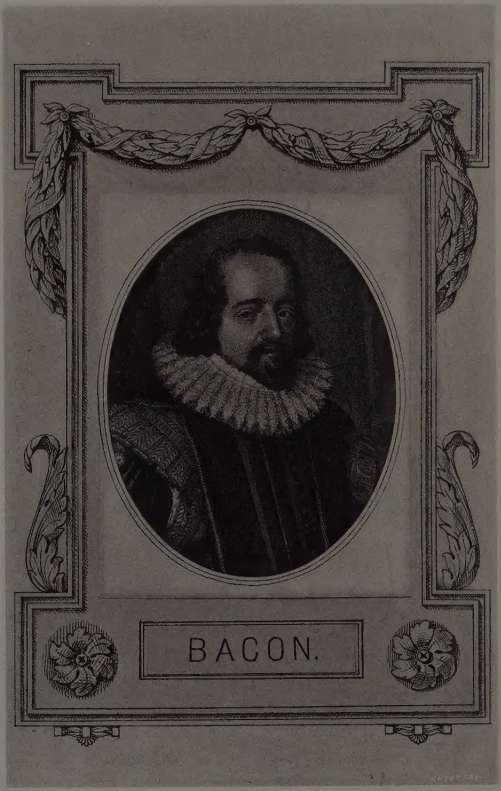
BACON.

FRANCIS BACON

HIS LIFE AND PHILOSOPHY

BY

JOHN NICHOL

M.A., BALLIOL, OXON., LL.D.

PROFESSOR OF ENGLISH LITERATURE IN THE
UNIVERSITY OF GLASGOW

PART II.

BACON'S PHILOSOPHY

WITH A SKETCH OF THE HISTORY OF PREVIOUS
SCIENCE AND METHOD

WILLIAM BLACKWOOD AND SONS
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PREFATORY NOTE.

Bacon, being the first after the close of the middle ages to give a new direction as well as a new aim to speculative research, was as much a critic of old as a promoter of new methods; and it seems not inappropriate to preface a survey of his system by a glance at the preparatory work of his predecessors. In the first part of the present volume, I am indebted equally for detail and general suggestion to the comprehensive works of Dr Whewell, the 'History of the Inductive Sciences' and the 'Philosophy of Induction.' I also acknowledge my obligations to the Essays prefixed to Professor Jowett's translations of Plato's Dialogues, especially that which introduces the 'Timæus.' My authorities for the fragmentary references alone here possible to the influence of the Arabians on European thought are, besides Whewell, M. Renan's 'Averroès et l'Averroïsme,' and the 'History of Philosophy,' by George H. Lewes. As regards the Mystics and Alchemists, I have principally

relied on Vaughan's 'Hours with the Mystics,' the Essays of the late Dr Samuel Brown, and the recondite pamphlets of Professor John Ferguson. For a general view of the relation of early Science, History, and Literature, every writer will confess himself a grateful student of Hallam's 'Middle Ages' and 'Literature of Europe.' On questions of date and of spelling I have constantly consulted the French 'Biographie Générale,' and the 'Dictionnaire des Sciences,' Hachette, 1844-1852.[1]

As an interpretation of Bacon's own Philosophy, I have found the critical notes of Mr Robert Ellis to exceed all others in thoroughness and insight — an opinion which, if we may argue from their following in his track, his successors in commentary seem to share. I must also refer to the clear contrasts of old and new methods in the work of Kuno Fischer; to the brilliant summary of M. de Rémusat, for its estimate of the after influences of the Baconian mode of thought; and to Mr Benn for a remarkable appreciation of the influence still exerted over the mind of Bacon by that of Aristotle.

[1] In the spelling of Arabian names I have followed these authorities in giving them as they are best known to general readers, the more confidently as there is often a confusing variance in the use of these names by Arabic scholars—*e.g.*, M. Renan in p. 55 of his book refers to Algazel as Algazali, while in p. 73 and elsewhere the same philosopher appears as Gazali.

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FRANCIS BACON.

I.—BACON'S RELATION TO THE PAST.

CHAPTER I.

THE 'REDARGUTIO.'

The mass of criticism, English, German, and French, accumulated about the Baconian Philosophy, still leaves room for difference of opinion regarding its degree of inaccuracy in detail and failure in result: there is no room for difference as to its design, which was to explore the Universe, and, under reverence for the mysteries of Faith, to make men its masters. The popular view of the subject is condensed in Lord Macaulay's brilliant and shallow review, of which the following is the gist:—

Bacon was neither a philosopher nor a logician, but a practical reformer. Unlike his predecessors — who wasted their dialectic on labours like those spent on

a treadmill—his desire was not to solve enigmas, but to multiply enjoyment and mitigate pain. Century after century, during the evening of Greece, the meridian of Rome, the darkness and the twilight before the new dawn of Italy, rival sects had been repeating their idle cries, the Epicurean adding as little to the quantity of pleasure as the Stoic to that of virtue, or the Scholastic to that of knowledge. At last there came a theoretical philanthropist who, caring nothing about the grounds of moral obligation or the freedom of the will, disdaining disputes as barren as the toils of the damned in Tartarus, made Utility and Progress his watchwords, and, leaving the windy war to those who liked it, was content to contribute to the sum of human happiness. Macaulay devotes ten pages to a contrast of the treatment of the sciences—Arithmetic, Geometry, Astronomy, Medicine, and Law—in 'The Republic' and the 'De Augmentis,' the one work regarding them as steps to abstraction, the other as aids to invention, and concludes: "The aim of Plato was to exalt man into a god; that of Bacon to provide him with what he wants as a man. The one drew a good bow, but shot at the stars; the other fixed his eye on a common targe, and hit it in the white." But, continues the reviewer, the notion that Bacon found a new way of arriving at truth rests on no better grounds than the medieval belief in Virgil as a conjuror. Induction has been practised from morning till night by every human being since the world began. The man who infers that mince-pies have disagreed with him because he was ill when he ate them, well when he ate them not, most ill when he ate most, and least ill when he

ate least, has employed, unconsciously but sufficiently, all the tables of the 'Novum Organum.' The right or wrong use of induction depends not on rules but on brains. The objects of preceding speculators did not require induction for their attainment: Bacon stirred men up to pursue an object which could only be attained by induction, and consequently it was more carefully performed. This is the sum of the benefit he conferred on society, and the total of his so-called philosophy.

Three manifest defects combine to render this inadequate even as a popular presentation of the system it professes to unfold:—

1. Its Historical incompleteness. The critic has merely travestied the Greek schools of thought.
2. Stating so far correctly what Bacon has done, it leaves us with hardly any conception of what he meant to do.
3. It makes Bacon a mere Empiric. An observer and experimentalist, he was also a philosopher animated by a spirit far less removed from that of the ancient thinkers than Macaulay imagines it to have been.

To understand the system we are called on to examine, we must search more widely through its antecedents, and examine more minutely into itself.

Bacon aimed at being both a critic and a creator: in the former *rôle* he is often unjust, in the latter his embrace was in some respects like that of Ixion; but in both he has left on thought, as on literature, an indelible mark. No part of his design is more definite than the determination, characteristic of his age, to

break with the Past, although no part of it was more incompletely fulfilled. The most eloquent of his attempts[1] to brace himself to the impossible breach is the harangue, supposed to be addressed to an audience of seekers after truth at Paris by a mysterious stranger who takes his seat among them as an equal, but comes with an inspired message.

The date of this piece, entitled 'REDARGUTIO PHILOSOPHIARUM,' is nearly determined by an allusion, "Meditor Instaurationem Philosophiæ," which shows it to be meant as an introduction to the author's already conceived scheme, and written after he had begun to miss co-operation in his work. "Quos socios habes? Ego certe in summâ solitudine versor." It is the "oratio ad filios," mixed with elegancy, novelty, and superstition, suggested in the 'Commentarius,' and M. Bouillet has reasonably conjectured that it is the MS. re-

[1] Not, however, the first. In a letter to Father Fulgentius (1625), Bacon refers to the constancy of his mind, which has "not grown old or cooled in this pursuit since, forty years ago, he, with a magnificent title, named his first effort 'The greatest birth of Time.'" The 'Temporis Partus Maximus' is lost. If it was identical, or nearly so, with the 'Temporis Partus Masculus,' the censure of the scholar Henry Cuffe—"a fool could not have written it, and a wise man would not"—is just. If the latter be a juvenile production, it betrays an arrogance rare even at the age of 25; if, as Mr Spedding conjectures, it was written in 1608, on the lines of the hint in the 'Commentarius Solutus,' "to discourse scornfully of the philosophy of the Grecians," it displays a dramatic dishonesty in depreciation. In this fragment as elsewhere, respect is paid to the thinkers who are to philosophy as the heroes before Agamemnon. Their successors are arraigned with a violence comparable only to the censures passed on each other by rival politicians, commentators, or theologians. Aristotle is "pessimus sophista"; Plato, "cavillator urbanus"; Ramus, "literarum tinea"; Galen, "canicula et pestis"; Cornelius Agrippa, "trivialis scurra"; Paracelsus, "asinorum adoptiva"; and the Copernicans, "terræ aurigæ."

ferred to in the letter of October 10, 1609, to Toby Matthews :—

"I send you the only part which hath any harshness ; . . . this other speech of preparation . . . is written out of the same necessity. Nay, it doth more fully lay open that the question between me and the ancients is not of the virtue of the race but of the rightness of the way. And to speak truth, it is to the other but as palma to pugnus, part of the same thing more large."

In comparing the 'Redargutio' with the 'Partus Masculus,' we find the view more comprehensive, the judgments more tempered, the style indefinitely raised. It is like passing from Milton's railing at Salmasius to the stately Latin of the Address to the nations of Europe in the 'Defensio Secunda.' We have less of the fist in fight, more of the helping hand. For contempt we have conciliation ; for the "de alto despiciens," the constantly repeated reference to the French who came to Italy with chalk to mark rather than with arms to storm their lodgings. Bacon now respects his predecessors, while demurring to their conclusions : of his former "verborum ludibrium" and "theologus mente captus," he now admits "ingenia certe illorum capacia, acuta et sublimia." He, however, still regards them as usurpers of a throne—a superior kind of sophists blinding the minds of men. Aristotle is the Ottoman who kills his brothers to reign alone, constructing the world out of categories, juggling with nature, coming in his own name, dropping a curtain over the earlier age, the tyrant whom it is the first duty of the leaders of an inevitable rebellion to depose.

The oration[1] itself, the main part of the essay in which these criticisms are set, opens with an appeal to the audience as heirs of a high inheritance,—"men not animals erect, but mortal gods," "Deus mundi conditor et vestrum, animas vobis donavit mundi ipsius capaces; nec tamen eo ipso satiandas." This noble estimate of man's prerogative in the mental, in contrast with the author's mean view of men in the political world, is followed by a reference to our forlorn state in being doomed to live so long on one food variously dressed—*i.e.*, on a small part even of the old philosophy, on the writings of six autocrats—Plato, Aristotle, Hippocrates, Galen, Euclid, Ptolemy. Nor is much of value gained if we add the labours of the alchemists, save that, like husbandmen digging in vain for gold, they broke the soil; or the crude guesses and haphazard experiments of later physicists. Our wealth is small because we have misused our capital—*i.e.*, the faculties designed by the Creator for the best choral hymn to His praise, the study of the heavens and earth. Keep, says the speaker, your inherited learning to adorn discourse, and win esteem. For that the new philosophy will be of small avail; it is not on the surface, nor can be snatched in passing, "nor in broad rumour lies"; it can only appeal to the multitude when its results are manifest. Concede to the old fashions, but as shows, not fetters. Have Lais, be not her slave. Reserve yourselves for better things. See that your minds be sound, then use

[1] A summary of the whole of this comprehensive oration, which presents in more artistic form all that is important in the "Pars Destruens" of the 'Novum Organum,' having been given by Dr Abbot, I restrict myself to referring, and that not always in their actual order, to the most salient passages.

them: before building prepare the ground, cumbered now with traditions of the Greeks,—"children ever," as said the Egyptian seer, reared in an age of fable, scant of history, with no more knowledge of the earth than from tales and journeys which, compared with ours, were suburban, or of their neighbours, than to call all those to the west Celts, to the north Scythians. In this barrenness their minds fell a prey to those who went from city to city, making and selling rhetoric; or to those who, with more haughty dogmatism, opened schools and instituted sects,—that of Aristotle in chief, who corrupted the study of nature by dialectic; as Plato did by theology, diverted from following the true path by his superficial knowledge and soaring abstractions. As for the yet older philosophers who, far from strife and pomp, disdaining to sport, like Galatea, in the waves of disputation, rather half asleep like Endymion on a hill, gave themselves up to thought and research; these merit a higher place, as having penetrated often more deeply into the secrets of nature, and been closer observers of her ways. But their hearers were a few select disciples, and their works, more known under the Cæsars (*teste* Juvenal, x. 48), must have been destroyed by Attila and Genseric and the Goths, for they remain to us only in fragments, often hard to reconcile. Lastly, as far as we can judge, even their dogmas and speculations were like stage arguments, where much that is true is mixed with the fancies of fable. Their discoveries, many of them genuine, were made by wit and industry, but without any consistency of method. The ship of Greek philosophy is one, the wanderings various, the

causes of wandering the same—*i.e.*, the want of a compass. That this is not the popular judgment is in our favour. "Pessimum certe omnium augurium est de consensu in rebus intellectualibus."[1] That Greek was wise who asked, "What have I said amiss that the mob applaud me?" Let honour remain with the ancients, but no longer blind belief; and treat us as the rest. We claim credit only for our method and our aim; and a lame man in the right way will beat the swiftest racer in the wrong. We are finger-posts, not judges, in saying that were all the wits of all ages rolled in one, in the present mode no great progress could be made; nay, the more capacity there is in the man who leaves the light of nature—*i.e.*, its history and facts—the further he will lead us astray. What spiders' webs, wonderful, subtle, and useless, have the schoolmen, made fierce by the darkness in which they have been reared, woven around us! Our confidence is no boast, for the new method will make all men equal; 'tis not by steadiness of hand or eye, but by the compass and the square, that we propose to draw our lines and circles. We rather dread than hail the quickness of untrained powers, and would give them weights, not wings. For up till now men have never known how straight is the way of truth.

To fortune rather than merit let us attribute that we are no longer abandoned to the waves of chance, but may now hope to find the middle way between mere experience and opinion; nor wonder that we have had

[1] Bacon adds here, "exceptis divinis, cum veritas descendit cœlitus;" and in 'Novum Organum,' i. § 77, "et politicis, ubi suffragiorum jus est."

to wait, for it is a mixture of diffidence and scorn which has so long retarded the discoveries which, once made, seem inevitable. Whether they were known before is doubtful. There is a veil hanging over the remote antiquity before the dawn of philosophy. One might well believe that there had been something there prophetic of the future, had the old records not been corrupted by those who have wished to claim authority for their own views. It matters little to inquire whether America be really the new world or the old Atlantis rediscovered, for our task is to discover from the light of Nature, and not to recover from the darkness of Eld.

The imaginary speaker returning to the Alchemists, censures them for adopting the theory of the four elements of Aristotle and Empedocles, and drawing from them preconceived analogies, as four complexions, four humours, four conjunctions of primary qualities, and for their superstitious use of natural magic. Bacon then proceeds to talk of deluding prepossessions, and contends that every Philosophy must be judged by its fruits, comparing that of the Greeks to Charybdis or Scylla, fair above, with barking monsters famous for great shipwrecks below. He next animadverts on the habit of looking merely at isolated facts, without considering the unity of nature—as if one should carry a small candle about the corners of a room radiant with a central light; and again condemns the challenges and disputes of the schools, preferring with Cato that Carthage should be destroyed, rather than with Scipio Nasica that it should be preserved as an exercise-ground. Passing to auguries from the progress of the arts, he contends that they should be brought into relations with philosophy by

being referred to their sources and systematised. Where they are defective, it is no fault of nature, within which lie boundless possibilities, to doubt which is to condemn mankind, as the sceptics of the Academy did, to eternal darkness.

But, says Bacon's mask in this opening scene of his great play, time flies while we are wandering smitten with love of the theme, and longing for the initiation which is to melt the frosts like April. Let us ask how it is to be accomplished, and answer by using all the aids within our grasp. He were a madman who should try to shift an obelisk by mere force of hand, however strong: so were he who would have men apply unaided intellects to solve the problems of the universe, and discard the means of guiding and combining their efforts. We have more to do than collect facts, and then spend an age in revolving theories; as if we were looking from a tower, till the world seems to our eyes like a cloud in which difference and shade are lost. Similarly the ancients, from a few experiments made captive to a foregone conclusion, rose at once to the most general axioms, and remained with them as at the poles of controversy. We must leave those heights and come into the plain, there mingling with our fellows and enlarging their estate. From these new nuptials of the Mind with Nature shall spring a race of heroes, of later birth but higher destiny, to subjugate monsters, to relieve the wants of men, and chase the shadows of the night.

Bacon then passes, by a somewhat sudden jerk, to the division of the Faculties into Empirical and Rational, which, he says, should work together. Apart, the former

merely gather like the ants; the latter weave webs like the spiders. Between is the fashion of the bee, that, drawing material from grove and garden, transmutes it. So true philosophy passes the matter of observation and experiment through the mind, and brings forth "hujusmodi mellis celestia dona." The oration concludes with an exhortation to be of good heart, and dread no lion in the way; nothing will give such cheer as the daring of the age, "facinora ætatis nostræ": replace *non ultra* by *plus ultra*, and you will find that Jove's bolts can be forged on earth. Go forth with the sentence of Alexander, "Nil aliud quam bene ausus est vana contemnere."

This review is an epitome of all the writer has said in so many forms of the ancient philosophy in the numerous and varied introductions to his own. To appreciate its accuracy on one side, its inadequacy on another, it is necessary to survey his antecedents, so far, at least, as to understand where the previous thinkers, by most of whom he was influenced, though frequently by antagonism, came legitimately within the scope of his criticism.

CHAPTER II.

METHOD AND SCIENCE OF ANTIQUITY.

Bacon, it has been hastily said, was a Logician, not a Philosopher. He had, it is true, formed no consistent scheme of the universe ; but his method was determined by his view of the matter with which he had to deal. Logic, far from being an end in itself, was to him emphatically a means, and the defects of his system are directly traceable to the imperfection of his Science. The larger half of his work being a criticism of the Past, we must, in order to estimate its value, endeavour, at least proximately, to realise the amount and nature of his intellectual inheritance.

As the 'Republic' and 'Timæus' of Plato sum up and concentrate nearly all the previous speculations of Greece, so in the 'Instauratio Magna' we find reflected, though often distorted, two thousand previous years of thought. Bacon's whole attitude is that of hostility to the medieval mode of reasoning which had grown out of the decadence of the Greek philosophy. The first recorded speculations of Europe are attempts to generalise on the data of a few phenomena. The Ionic theorists aim at discovering a physical unity in referring the changes of

nature to a single element, but without any conception of a true physical method. They are followed by more abstract thinkers, who, denying the reliability of sense-impressions, endeavour to bring everything under the control of a mental idea. The inadequacy of Bacon's criticism is nowhere more conspicuous than in his mistaking their random physical conjectures for the essential points of their systems. Neglecting the central conception of Heraclitus, who regarded the world as a series of dissolving views, he dwells only on the fire, which was an emblem of the perpetual flux, and, similarly, he comprehends the mere phenomenal fringe of the Eleatic Idealism. His notes on the Atomists are more appreciative; but in referring to Anaxagoras—in whom the modern historian recognises the first Greek who had a glimmer of the distinction between the laws of mind and those of matter—he confines his attention to the 'Homoiomereia.' The pre-Socratic philosophers were only scientific by accident. There is hardly any result of modern science which they do not seem dimly to foreshadow; but the vagueness so obscured the suggestiveness of their conclusions, that when they met and clashed, towards the close of the fifth century B.C., at Athens, the Sophists found a ready audience for their negative thesis: "Πάντα ῥεῖ is as true within as without, we know not anything; but there remains the art of life." Socrates seems to have been as sceptical as Protagoras in his view that the universe was past finding out: he abandoned speculations περὶ τῆς ὅλης φύσεως, and maintained "the proper study of mankind is man." It is true that he so far succeeded in reconstructing Ethics, by appeals to a finer analysis of

the mind, substituted for *savoir faire* firmer bases of practical belief, and gave to Western thought a moral dye that has never been wholly worn out; but from Bacon's point of view his position was distinctly retrograde. In elevating the Socratic "definitions" into "Ideas," in substituting a more elaborate dialectic for the Socratic "elenchus," Plato restored the translunary metaphysic his teacher had discarded. In the Dialogues, which have been aptly termed his "plays," the previous world of thought converges, as in a reservoir from which the rivers of the after-world flow; but the physics of the 'Timæus' are a mere *réchauffé* of Pythagorean and other phantasies, where imperceptible triangles are made to do duty for the atoms of Democritus, and the crudest physiological assumptions take the place of the anatomical or biological facts reserved for the labour of centuries to ascertain. Aristotle, the first great analyst among philosophers, marked the lines of demarcation between Politics, Ethics, and Theology, and tried to exhibit the relation between Psychology and Metaphysics proper. With him formal Logic all but begins; with him it all but ends. He replaced the Ideal Paradigms of Plato by his own theory of "Forms"—*i.e.*, the qualities essential to things being considered to be, and being (for in his system the conception and the reality are merged[1]), what they are,—qualities which he sought by observation, investigation, and, though more rarely and roughly, by experiment, to discriminate from accidents.

In the works of these masters most mental problems are so defined that, in many directions, later ages have only filled in details; and Aristotle, in his wide accumu-

[1] They are so in equal degree in the philosophy of Bacon.

lation of facts, showed himself a student of natural history; but in extending the kingdom of man over nature, they were little in advance of their predecessors. Their near successors, in formulating their doctrines as tenets of rival schools, only contracted their scope, and more unreservedly abandoned the lines of real physical research. Epicurus and Zeno enlarged the ethical views of Aristippus and Antisthenes; but the cosmological theories of Democritus and of Heraclitus, with which they became respectively associated, remained in their hands mere abstract speculations. The great work of Lucretius displays a poetical interpretation of nature often only surpassed in subtilty by Wordsworth; nor are there wanting in its pages occasional references to crude experiment, and a few anticipations of correct theories of the world such as we find somewhat later in Ovid's 'Fasti'; but these are interwoven with views fundamentally false. The services rendered by the Stoics and Epicureans to mankind consist in their criticisms of life. These naturally impressed themselves on the practical genius of Rome, at a time when the Empire was being established, and men were divided between those ready to let the world slide and those who were vainly endeavouring to revive the old life of the Republic. Side by side with these two schools we have the modified negations of the New Academy. Cato would have expelled Carneades for undermining morality; Bacon regards his doubt, "acatalepsia," as a bar to science, profoundly observing that "he who has once despaired of arriving at truth, finds his interest in all things less." Greek philosophy had wrought out, in the only ways open to the existing state of knowledge, the chief ques-

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tions it had started. Coming into contact with another era of civilisation, it was cramped by legality and formalism before having to succumb to the dominance of the new religion. During the centuries of its wane we meet with various substitutes for genuine research, represented by the following types of confused or superficial thought: the *Dogmatist*—the Baconian spider—who lays down opinions in a final way without caring to give reasons for them; the *Empiric*, who, on the ground of a few facts or coincidences, compiled as the ant gathers rubbish, forms and acts on narrow views; the *Eclectic*, who pieces together often discordant parts of several systems, with the idea that somewhere among them the truth must be found; the *Sceptic*, who, weary of the search, impatiently denies; and the *Mystic*, who trusts in a new imaginary faculty—resolving itself for the most part into a diseased fancy or vague emotion—to supply those truths which he holds to be above reason.

The Academicians and the Peripatetics are distinguished from the masters of their respective schools by their mixture of scepticism and dogmatism: whatever in the teaching of Plato and Aristotle would not readily submit itself to dogmatic treatment, of that they were sceptical. The Romans generally were eclectics, — an attitude variously represented by Cicero, Plutarch, and Pliny. The later Epicureans inclined to empiricism; and their Hedonism, after being degraded in Petronius Arbiter, was relegated to practical life till it was revived in the Renaissance. The asceticism of Zeno and Cleanthes gave way to, not without influencing, Christianity. The mysticism of Alexandria, gathering together the abstractions and myths of the

East and West in a strange farrago, affected, though in disputed degree, some of the Fathers, before it passed with Proclus, after having had its king in Julian and its martyr in Hypatia. It is hardly true to say that Bacon understood Greek philosophy only as distorted by those mists, for there is evidence of his having read, even if he did not carefully study, some of the original authors; but he insufficiently disentangled their teaching from that of the commentators, and involved them in the same condemnation. The modern student sees a chain of thought in the ancient schools; but their true relation is often difficult to detect, for it is generally unconscious. Each successive thinker seemed to himself to have found the secret of the world, and proclaimed it with a religious ardour. We see that each introduced some idea that has not been wholly lost; that for many of our conceptions we are indebted to what has descended to us through so many channels; that we are what we are, in some degree, because of speculations to question the utility of which is to question the utility of mental science; that to gauge them by practical results is like asking the use of a poem or the shape of a colour. But this view, to which we have been educated, is that of a critical age. It might have been possible to Lord Macaulay in the 19th century; it could hardly have been entertained by Lord Bacon in the 16th,—a century not of criticism but of self-confident assertions. What Bacon could see was the undoubted fact that the ancients had done almost nothing to promote our power over external nature. His verdict was one-sided; but from one side it was correct. The Greeks speculated about everything; but the positive results—

such results as were the main object of his pursuit—which they arrived at in physical science, may be recorded in a few pages.

The laws of number and form taught by Pythagoras, and soon expanded into a system that is still the basis of GEOMETRY, do not properly belong to physics. ASTRONOMY is the most ancient of the sciences, because it relies so much on calculations that call for no experiment. Its mathematics had made great progress almost before the question of its physics—*i.e.*, the consideration of the forces that regulate the movements of the heavenly bodies—had been started. It began with the first conception of times and seasons. The alternation of light and darkness marked the day, a slight exercise of memory the year, the phases of the moon the month. The course of the sun through the zodiac seems to have been fixed by the Egyptians about 2500 B.C., and eclipses arrested attention from remote antiquity. Early observation distinguished the revolution of the constellations from the dance of the "seven wanderers." Pythagoras identified Lucifer and Hesperus; he himself or Philolaus, or another of his followers, asserted the motion of the earth round a central fire. The most poetic representation of the Pythagorean universe is found near the close of the 'Republic': but the astronomical part of the 'Timæus' is a retrogression; for while Plato's view of the diurnal revolution of the earth is uncertain, he makes it the centre round which the fixed stars, as well as the planets, revolve—those within our orbit in one direction, those without in another. He, however, distinctly asserts the spherical form of our globe, and in one passage remarkably anticipates the medieval ob-

jection to the antipodes;[1] though he runs off from the truth to a series of phantasies regarding "kindred elements," &c. Aristotle, with all his more definite research, made in this direction no further progress. Meanwhile, as contributions to geographical knowledge, Anaximander had constructed the first map, Anaximenes the first dial; and the zones, still retained in our nomenclature, had been marked. Later, the irregularities of the planets eluding the simple hypothesis of opposite directions, the fiction of epicycles was introduced to reconcile them with the postulate of circular motion, which kept fast its hold on astronomy till the time of Kepler; Eudoxus and Calippus multiplied those imaginary spheres. Hipparchus (fl. 160 B.C.) added the conception of an eccentric—or circle revolving round a body displaced from the centre—discovered the precession of the equinoxes, constructed lunar and solar tables, catalogued the stars, and supplemented the geometry of Euclid by treatises on trigonometry. His conclusions were extended, and apparently verified, by the calculations of Ptolemy (fl. 150 A.D.), whose 'Μέγιστη σύνταξις,' the Arabic "Almagest," became the canon of the Ptolemaic, or more properly Hipparchian system, which remained practically unshaken for 1500 years. Ptolemy has the credit of admitting that the circles, which in the popular fancy had come to be regarded as substantial sources of the "sphery chime," were mere geometrical expressions, on the basis of which a theory could be constructed to

[1] "Such being the nature of the world, when a person says that anything is above or below, may he not be justly charged with using an improper expression? for the centre of the world cannot be rightly called either above or below, but is the centre and nothing else."

resolve into uniformity all the previously observed phenomena of the heavens.

The story told of Pythagoras and the hammers and weights indicates an acquaintance with the tone of musical notes, as depending on the length of the chords, which established HARMONICS on something like a scientific basis. This application of the same ratios to the planetary distances, and of abstract mathematical theories to both, reappears, with hardly less freedom from half-mythical and wholly fantastic conceptions, after an interval of 2000 years, in the first cosmological theories of Kepler. Further than this, the ACOUSTICS, as the OPTICS of the Greeks, rest on the assumption of emissions and transmitting media, or *species sensibiles* appropriate to the ear or the eye,—an assumption founded on the maxim that all change implies contact, conspicuous alike in the speculations of the Stoics and Epicureans, accepted equally by Bacon and the Cartesians, and lingering in Newton himself. Aristotle was aware of the fact that light proceeds in straight lines; but his investigations were arrested by premature theories of its cause. Euclid discovered the equality of the angles of incidence and reflection, and Ptolemy recognised, and attempted to measure, the law of refraction. Greek MECHANICS and HYDROSTATICS almost begin and end with Archimedes (290-212 B.C.) Previous to his time their progress had been stopped by false views as to the nature of force, pressure, and motion. He was the first to form a clear conception of a centre of gravity, and from it deduced the correct theory of the steelyard, and came near the solution of the problem of the lever. Realising the conditions of a

body in which pressure is transferred from one to all its parts, he made use of the calculation of specific gravity in his celebrated analysis of the Crown; and enunciated the law by which a narrow column of fluid balances a broad column of the same weight,—afterwards so long forgotten, that, on its revival, it was called "the hydrostatical paradox." Neither Statics nor Dynamics made any further advance till the time of Leonardo da Vinci, and no continuous progress till that of Galileo. Bacon himself, in his practical knowledge of them, fell behind Archimedes. The definite attainments of the Greeks in the more complex sciences of Meteorology, Biology, Chemistry, &c., are confined to the observation of a few elementary facts, and the hazarding of a few often highly suggestive conjectures. In these have been found the germs of the Nebular and Darwinian and Copernican theories, of the doctrine of chemical affinities; of the discovery of sex in plants[1] as well as animals; of the belief in the indestructibility of either matter or force; of the transmutation and correlation of forces, and the resolution of qualitative into quantitative differences. But if discoveries deserve the name only when they have been proved, the best of these guesses must be regarded as finger-posts to future investigation. In one department, a true physical principle seems to have been laid down with practical results. The initial aphorism of the 'Novum Organum' is curiously anticipated in the assertion of Hippocrates (whose re-

[1] For an extension of this list, and a general criticism of Greek Physics, I refer to Dr Whewell's 'History of the Inductive Sciences,' and to Professor Jowett's Introduction to the 'Timæus,' *vide* 'Dialogues of Plato,' vol. iii. pp. 577-595.

puted date makes him the junior of Socrates and senior of Plato) that the physician must be ὑπηρέτης φύσεως. Galen, 600 years later, quotes this expression with approval as the key-note of the system of the "divine old man," who refused to attribute diseases to the wrath of the gods, and largely relied for their cure on the "vis medicatrix naturæ." The same disciple adds that Hippocrates was a more faithful student of nature than Aristotle, and that his method had been infringed by later empirics. But however fruitful may have been the maxim of the father of medicine, the subsequent assertions of the 'Timæus' regarding the composition and action of the human frame exhibit the most primitive and crude physiology.

How little has Greece bequeathed to us in the way of physical discovery! How little has been added to the pure speculation of the Greeks! There is no more remarkable contrast of sterility and luxuriance. To explain it is to repeat in yet more modern form much of Bacon's criticism of the ancient thinkers. If we ask why, during those active centuries, there were no thinkers able to apprehend and willing to apply the principles on which a fruitful investigation of Nature depends, we may answer that there are eras which seem to admit of the exercise of thought only in one direction. We may associate the dawn of philosophy with the ardour of a child putting questions the answers to which he cannot understand, — inventing toys and dreaming dreams; we may draw an analogy between its full developments in Greece and the metaphysics of youth, and compare the growth of practical science to the entrance of manhood into life. But some more definite reasons for

the contrast, of which the following are the chief, may be assigned:—

1. In our minds, Theory and Practice suggest each other. Science is in advance of Art: the head waits for the hands. Consequently, it seems strange that the ancient artists and inventors so rarely realised the simplest of the principles of which they so successfully availed themselves. There is, however, no need, as Bacon sometimes inclines to do, to imagine a lost science in order to account for this; for the empirical knowledge which is enough for Art—the use of dials, levers, pulleys, the wine-press, and the still—often precedes Science by centuries. All the resources of the inclined plane must have been employed on the Pyramids; its principle, unknown to Bacon, was first demonstrated by Stevinus (fl. 1620). The class of those who discover is still somewhat distinct from that of those who apply their discoveries. In the days when speculation did not feel honoured by being put into practice, the classes were quite distinct. Lord Macaulay inclines to exaggerate the claims of immediate utility. Plato, oppositely, censures those who think of mensuration, navigation, or agriculture in their pursuit of astronomy, the object of which should be "not to note the stars, but to understand the revolutions of the celestial spheres." Every step in the ladder of knowledge should, he maintains, be an approach, not to axioms that are to redescend in fruits, but to the conversation of the mind with itself, the end of which is the vision of truth. In this spirit he is rumoured to have reproached Archytas for his machines, as Seneca long after defended Democritus from the charge of inventing the arch,

and Archimedes, inspired by what Bacon calls "deliciæ et fastus mathematicorum," is said to have been half ashamed of his own inventions. There is a point of view from which Plato's arguments have force, but it is not that of physical science; and while his views prevailed, theory and practice naturally remained apart.

2. While the Greeks thus lacked the spur of one of the most powerful motives to the attainment of physical truth, they were led astray by a misconception of its nature. They looked upon law as an idea rather than as an external uniformity or sequence: hence they imposed their reflections on the world, and concluded "potius ex natura hominis quam universi." They thought that all the oppositions of the mind had a real existence, and in their search for correspondences often wandered in the air. The pioneers of generalisation—to whom Bacon has hastily conceded an instinct for research—had not reached the stage of scepticism. Like the poets, from whose myths their speculations sprung, they hardly took time even to observe nature, but placed figments behind her shows, and thought they explained them. Water, Air, and Fire are with them mere watchwords of a wish to force unity on variety. Their attempt to solve all the secrets of the universe was a bar to real discovery, as it was to Bacon, who stretches out hands to them over the abstractions of 2000 intervening years. Thales noticed the powers of the magnet, but was content with the assertion that it had "a living soul." He had a notion of the expansion of water, as Anaximenes had of the rarefaction of air, but neither touched on the properties of steam or the gases. The theories of Lord Monboddo and the 'Vestiges of Creation' were super-

ficial precursors of Darwin's, based on inadequate facts acquired by rumour. The cosmogonies of Anaximander and Empedocles were similar theories, based on no facts at all. Heraclitus spoke of ἀναθυμίασις with no more study of the laws of evaporation than guided Herodotus when he spoke of the sun *drawing* the waters of the Nile. The Atomic philosophy is said to have been suggested to Leucippus, not by any analysis, but by a contemplation of the Milky Way.

3. Bacon is never done descanting on the futility of the method of the Greeks. In the so-called "pure sciences," dependent on more or less obvious deductions, they excelled; but they failed wherever more complex phenomena required to be selected, tested, and sifted by a legitimate process of induction. That all men, in all ages, have practised induction, is a truism; but Macaulay, by a notorious *ignoratio elenchi*, confounds induction as an art of life, and the Inductive Method as a scientific process. Of the latter the ancients had no well-defined perception. They accumulated often considerable stores of facts, but without any clearly conceived design. Herodotus, Democritus, and Aristotle were all, in a sense, great observers; and it has been duly acknowledged that the latter, at least, bestowed great pains on arranging the results of his observation: according to Dr Whewell, his 'Natural Histories,' have seldom been surpassed in comprehensiveness of classification; but, as the same critic has shown, he failed equally with his predecessors in applying to facts the appropriate ideas required to weld them together, and suggest or elucidate a law. Socrates taught the necessity of search for the true connecting link in Ethics;

Plato applied the same principle to Metaphysics, Aristotle to Politics; but it never descended to Physics, which remained under the control of notions "temere a rebus abstractæ," and incapable of definition. The early philosophers would not wait for knowledge to be unfolded by degrees. In the speculations of the Ionics, mythical cosmogonies are mixed with misinterpretations of mechanical, dynamical, and chemical facts. Hence they were content to derive organisation and life from fluids and solids of which they did not know the primary properties, and form theories of universal force without realising the facts of either motion or inertia. They made one step in analysis, and stopped; *e.g.*, no sooner had the notion of the four[1] elements been started than they were accepted as dogmas, holding somewhat the same position in physical as the four causes do in metaphysical speculations. Pythagoras having seized on the idea of number, mapped out the universe according to a pre-established theory of ratios, and made geometry the dictator rather than the servant of the sciences. Similarly, Plato refers truth to inspiration rather than to discovery. It is, he says in the 'Philebus,' "a gift of the gods to man sent by some Prometheus in a blaze of light; and the ancients, more clear-sighted than we, handed down this doctrine that whatever is said to be, comes of the one and the many. We must therefore endeavour to seize the one idea as

[1] Aristotle characteristically deduces them from the qualities of touch; hot, cold, wet, and dry. Setting aside the impossible combination of hot and cold, he asserts that the union of hot and wet is =*air*, as in steam; of hot and dry=*fire;* of cold and wet=*water;* of cold and dry=*earth;* and assigns to each "its own place" in the order of ascension—earth, water, air, and fire.

the chief point." We may compare this with Aristotle's dictum in the introduction to his 'Physics': "We should proceed from what is known to what is unknown—*i.e.*, from the universal to the particular," and contrast these canons with the first aphorism of the 'Novum Organum,' or with Galileo's scorn of the paper philosophers, who studied nature like the Iliad and Odyssey through a collation of texts, or with his famous sentence, "Philosophy is written in that great book—I mean the universe, constantly open before our eyes; but it cannot be understood except we first know the language and learn the characters in which it is written." For want of this initiatory study or a sense of its necessity, the Greeks were satisfied to rest in ideas indistinct and ambiguous, and their research was lost in generalisation before they had learned to spell in the book of the universe.

4. "There are," says Roger Bacon, "two methods of knowing—by argument and by experiment." In argument the Greeks remain unsurpassed, but the uses of experiment were to them almost unknown, and hence their ignorance of the sciences that rely for their initial steps on analysis. The assertion in the 'Timæus,'—"God only is able to compound and resolve substances; such experiments are impossible to man,"—was a bar to Chemistry more rigid than the later interdict of "Dominican or Franciscan licensers" on the progress of Astronomy or Geology. Where reflection and calculation sufficed, as in merely formal Astronomy, the ancients made considerable way; where experiment was required, they stood still. They had hardly any instruments to work with but language and logical forms, and to the fallacies

which these are apt to engender they became a ready prey. Many of Plato's arguments and more of Aristotle's criticisms seem to us to turn on words. Both agree in thinking there is something gained in the mere tautology of referring heat, cold, and motion to a *primum calidum*, *primum frigidum*, and *primum mobile:* both are captives to the mental dichotomy that, ranging all "things in heaven and earth" into such pairs as Knowledge and Ignorance, One and Many, Odd and Even, Motion and Rest, Being and Not Being, Atoms and Vacancy, Mind and Chaos, Matter and Form, Power and Act, in reality dropped a curtain over the real arena: both—the one "contingens cuncta lepore," the other with the glitter of his formulæ—lead us often through the same wood, and, after more wanderings than those of Spenser's Knight, back to the same entrance. It is owing to a recurring confusion between facts of consciousness and facts of sense that so much of Plato's reasoning seems to us to move in a circle; and to his being hampered by the tyranny of *à priori* ideas crowned and fenced that Aristotle could often be satisfied with such flimsy solutions as these:—

"There is no void; for there is no difference of up and down in nothing, and there must always be up and down." "The continuous is best, the best must always be." "Motion along the earth, being violent, ceases; motion down, being natural, increases." "The earth is composed of the noblest matter which has three dimensions, for three is the most perfect number: of it we say first, beginning, middle, end." "A man bends when he rises because a right angle is connected with equality and rest." "The powers of the circle are wonderful; but it is nothing absurd if something wonderful is derived from the wonderful. The combination of

opposites is wonderful. The circle is composed of a stationary point and a moving line, of a convex and a concave,—these are opposites and wonderful." "The simple elements have simple motions: the circular[1] motion of the heavens cannot be unnatural; it must come from a fifth element, the quintessence."

These are random examples of the manner in which technical terms, galvanised into a show of life, intruded themselves into physics with preconceptions of proper and improper, strange and common, natural and unnatural, up and down,—conceptions alien to their sphere and fatal to their progress. One of these errors so rooted as to claim special note was the belief that all things to which the same name[2] was given must be essentially alike. Another arose directly from the metaphysical view of the relation of cause and effect maintained by the Greeks. They imagined that an effect in nature gave the law or force in kind; that the cause was of the same form as the effect; whereas the effect, as far as we see in Physics, gives no indication whatever of the kind or species of its law. Causes, as mental forces, are early objects of consciousness in self-reflection; but effects alone are objects of consciousness, or rather of observation, in the study of external nature. For the first traces of this presumption of resemblance we have again to revert to the Ionic School, where we find prominent the idea of likeness between

[1] Eighteen hundred years after we find Copernicus himself still partially possessed by the same idea. "We must," he says, "confess that the celestial motions are circular or compounded of several circles, since their inequalities observe a fixed law and recur in value at certain intervals, which could not be unless they were circular, for a circle alone can make that which has been recur again."

[2] An error into which Bacon has fallen in his discussions on Heat.

an element and a compound that prevailed all through the middle ages. It lies at the root of the Homoiomereia of Anaxagoras, and the λόγοι σπερματικοί of the Stoics, and lingers in the cosmology of the Atomists. Aristotle's explanation of the round form of a luminous spot thrown by the sun, and his misinterpretation of the lever power, on the ground that the circle with the widest radius had more force, are instances of the fallacy. On the same principle, all fiery appearances in the sky were classed together as meteors; and the scheme of the revolution of the spheres was devised. It reappears in Galen's assertion that man's body must be of various elements, else he would never fall sick. It was revived in the chemical theories of Phlogiston, and though refuted by known facts of chemical,[1] magnetic, and electrical affinity, till lately lingered in the popular notion of Caloric.

The history of any one of the sciences demonstrates how hard it is to shake off inappropriate ideas once attached to them. It would have required a strong impulse, in a direction toward which they never turned, to dismiss the fallacies of method and aim so firmly grafted on the whole physical speculation of the Greeks. The Romans, the Latin poets, Cicero, and, in the main, the Stoics of the empire, echo the errors of their masters; but they added a greater confidence in progress, some faith in the future. The later Stoics have been accused of inclining to materialistic views; they may be credited with a partial return to Nature, and an attempt to reconcile theory and

[1] In modern science the Heraclitean πόλεμος πατήρ πάντων seems to have decidedly prevailed over the rival rubric ὁμοῖον ὁμοίῳ.

practice in their interpretation of ζήν κατά φύσιν. Seneca is conspicuous by his profession of a reverence for Physics. Unlike Socrates in this respect, and following Aristotle's dictum that there are many things in the universe greater than man, he exalted natural above human studies, on account of their sublimity. His ideal of ethics was the calm standard of "that great republic of gods and men, in which we measure our city by the course of the sun." A Lucretian with a Stoic mask, his maxim was, "I live according to Nature if I am her admirer and worshipper." Nowhere in antiquity is the forward-stretching glance of the panegyrist of James more nearly anticipated than in these sentences of the servile tutor of Nero:—

"It is not yet 1500 years since Greeks reckoned the stars and gave them names. There are still many nations who are acquainted with the heavens by sight only, who do not know why the moon disappears. The day shall come when the labour of a maturer age shall bring to light what is yet concealed. We have just begun to know how the shows of morning and evening arise. Some one will hereafter demonstrate in what region the comets wander. Let us not wonder that what lies so deep is brought out so slowly. Many things are reserved for a time when our memory shall have passed away. The world would be a small thing if it did not contain matter of inquiry for all the world. Eleusis reserves something for the second visit of her worshipper. Nature does not at once disclose all her mysteries. We think ourselves initiated; we are but in the vestibule." [1]

Science had to wait another 1500 years before the promise was fulfilled. Yet, amid the intervening wars of word and creed, some of the conceptions which have,

[1] Dr Whewell quotes this from Sen., 'Questiones Nat.', vii. 25.

during the last three centuries, borne luxuriant fruit, were silently growing up—

"Crescit occulto velut arbor ævo;"

and there were thrown forth, in the shape of vague conjectures, ideas which the latest developments of science seem tending to confirm. Great truths often dawn upon the mind long before they can be fully understood; or they come like a mirage in shadowy form. Some of the earliest thinkers seem to have attained, as it were through inspiration, the last truths of physics, but it was by the wrong road—the road of metaphysics. They reached the point at which the two meet, but by a premature anticipation of the goal from the start, and they did nothing to fertilise the long track between.

CHAPTER III.

THE DARK AGES.

THE same causes which retarded progress on one side during the ages of antiquity had the same benumbing effect on those immediately succeeding, and there were added new bonds. It is a mistake to suppose that authority has no control over thought; for to impose limits on its expression is to drive it to solitude, inertia, decay, and this was for more than a thousand years the ban placed on the human mind.

Towards the close of the second century of our era we have summed up, in Galen, Ptolemy, and Marcus Aurelius the last records of original speculation on the ancient lines; but the twilight, after the setting of the sun, lingers for three hundred years longer in the mystic eclecticism of Alexandria and the Christianised Stoicism, which heard its swan-song in Boethius. The Neo-Platonists supplied a link between the old and new Astronomy (a tradition prevails associating Hypatia with the first European observatory); but their theories were made valueless by a constant confusion of thought with learning, of knowledge with tradition, of inspiration with sentiment. Boethius studied the sciences in the

spirit of Plato: he dwells with special emphasis on the music of the spheres, and urges the smallness of the earth, as compared with the heavens, as an argument against vainglory; but his method was that of a strict Aristotelian, commenting reverentially on the 'Organon' and Porphyry's Predicables, accepting as an axiom the distinction of form and matter, and strenuously asserting the authority of formal logic. In this blending of two systems, and his distinctly expressed belief in genera and species as entities, he is the forerunner of the Realism of the middle ages.

The period from 250-550 A.D. is that of the most famous of the Fathers, of the early Saints, of the Arian and Athanasian wars, and of the first of the great Councils of Christendom,—all hostile to the growth of independent inquiry, and concurring to stifle the progress of mental as of physical research. "It is," says Eusebius, "through contempt of science that we turn our souls to better things." Tertullian is even more resolutely opposed to the secular learning which Lactantius openly denounces as false and shallow; and even St Augustine[1] imagines himself to refute the belief in the existence of the antipodes by the fact that no such race is mentioned in Scripture.

The Emperors of the age allied themselves with the same obscurantism. Constantine, fresh from his politic

[1] Augustine, however, alone among the Church authorities, seems to have had a glimmer of the future conflict, and shows his desire to avert it in the caution: "A Christian should beware how he speaks on questions of natural philosophy, as if they were doctrines of Holy Scripture. The opinions of philosophers should never be proposed as doctrines of faith, or rejected as contrary to faith, when it is not certain that they are so."

conversion, closed the schools, dispersed the libraries, and allowed science to be branded as magic; while Julian, whose love of nature was merely artistic, as reactionary on the other side, wished to interdict the Christians from the pursuit of studies that might be perverted to support their heresies. It has been said that Justinian, in banishing the later seven sages from Constantinople to the Court of Chosroes, "dug the grave of Greek philosophy." Charlemagne, Alfred, and our Norman kings, were patrons of the scant culture of their respective reigns; and Frederick II. of Germany established a new centre of polite learning in his Sicilian Court: but the Caliphs were the sole throned promoters of science down to the time of Alphonso of Castile. The history of thought during the dark ages is mainly the history of the Church. In the sixth century her struggle for existence was succeeded by imperious claims to supremacy, only held in check by the secular and national resistance of the Plantagenets, Capets, and Hohenstauffens. Hildebrand established a universal court of appeal, and dispensed to monarchs their right to rule. The candle that had been carried warily through the catacombs was now exalted on the shrine.

It is admitted that civilisation owes to the medieval Church a debt difficult to overstate. Her Popes fostered the early arts, her monasteries were the repositories of books, and the use of the Latin language, preserved in her ceremonials and her controversies, helped to bridge the gulf between two worlds. But these influences were injuriously exclusive; they gave a single bent to energies that might have otherwise expanded with the variety

of life, and gagged the free development of thought. The price mankind had to pay for a partial enlightenment was the sacrifice of its birthright to look beyond a fixed horizon. Under this paternal government all study had a preordained result—not truth, but orthodoxy; and the faithful had to enter the kingdom of St Peter's "as a little child." Dogmatism grew more and more intolerant of philosophy and afraid of science. The licensers of the intellect discouraged familiarity with the classics, and encouraged the superstitions that had the effect of threats on a fenced and guarded ignorance. The old manly Periclean virtues, *ἀνδρεία*, *σωφροσύνη*, *σοφία*, and *δικαιοσύνη*, were replaced by the spectres, chastity, humility, and obedience, which the monks and friars were supposed to represent, and the knightly orders were theoretically enlisted to enforce. The duration of this period of tutelage has been roughly marked by Hallam in speaking of Nicholas V. "How striking the contrast between this Pope and his predecessor, Gregory I.! These eminent men, like Michael Angelo's figures of Night and Morning, seem to stand at the two gates of the middle ages, emblems and heralds of the mind's long sleep, and of its awakening." This somewhat sweeping generalisation ignores the rehearsal of the Renaissance under Dante, Petrarch, and Chaucer, in the thirteenth and fourteenth centuries — a period almost as fertile in invention as in fancy; but it indicates the limits on either hand of ecclesiastical absolutism.

We must not, however, fail to note that, even in the soundest sleep of the dark ages, there were premonitory dreams. Gregory's missionary zeal was an incentive

to the cultivation of literature in the provinces. The early luminaries of the Anglo-Saxon Church, not content to be mere commentators, ventured with some freedom to record their views of the universe. Among these, Aldhelm is said to have been skilled in the liberal sciences; and that Alcuin is entitled to the same praise is shown by his account of the teaching he received in the school of Bishop Egbert at York. At a later period of his life, as the preceptor of Charlemagne, he taught (782 A.D.) at the school of St Martin at Paris on the following rule: "To some I administer the honey of the Sacred Writings; others I try to inebriate with the wine of the ancient classics. I begin the nourishment of some with the apples of grammatical subtilty. I strive to illuminate many by the arrangement of the stars, as from the painted roof of a lofty palace." This may seem a somewhat bombastic flourish of the rudiments of the *trivium* and *quadrivium*,—

"Lingua, tropus, ratio; numerus, tonus, angulus, astra,"—

which it was in the power of Alcuin to impart or in that of his disciples to receive; but it shows that, even under the lengthening shadow, the ancient traditions of culture had not died out, and that the desire to explore the secrets of nature still survived among the early scholars of our Ultima Thule. Similarly, Joannes Scotus Erigena, in his Christianised Platonic dialogue, speaks of primordial causes, types, or forms in language nearly applicable to physical laws, and discourses on the heavenly bodies with some knowledge of Astronomy. His guesses in psychology and physiology recall those of Anaximander and the 'Timæus,' and his whole specu-

lation is pervaded by the idea of man—with his fourfold life, corporeal, vital, sensitive, and rational—as a microcosm of the macrocosm, which, frequently recurring in after-ages, is so conspicuous in Bacon.

The period that followed down to the middle of the thirteenth century is generally regarded as the lowest ebb time of European thought; but the darkness was never complete, and during this era the intellectual activities of the West received a new stimulus from an unexpected source. It was the golden age of Saracenic literature,—of Haroun-al-Raschid, Jaafir al Mansur, and Al Mamun; of the Abassides at Bagdad, the Fatimites in Egypt, and the Ommiades in Spain, who, in their respective capitals, collected libraries, instituted schools, constructed observatories, and, preserving many important monuments of Greek literature that, during the decline of the Roman Empire, threatened to be forgotten, gave them a new though somewhat mutilated life. In the tenth century, students from all parts frequented the schools of Cordova and Seville, and brought back and diffused over France and Italy a knowledge of Algebra (of which science Gerbert, Pope Sylvester II., was conspicuously a master), of rudimentary Chemistry, and of the philosophy of Aristotle, whose works had been translated from Greek or Syriac into Arabic, and from Arabic into Latin. The influence of this learning is visible in our literature down to the close of the sixteenth century.

The amount contributed by the Arabians to the progress of science has been variously estimated, but it may be admitted that, in the interval from the date of Ptolemy to that of Leonardo da Vinci, they did more than

any others to keep alive something like a scientific spirit. In Astronomy, though generally adherents of the Hipparchian system, they deduced from its data some new conclusions, as—the mensuration of the earth by the risings and settings of the stars; the discovery of the disc and apogee of the sun, and the enlargement of the Ptolemaic tables by Albategni (850-929); the discovery by Aboul Wefa, 975 A.D., of the variation or 3d inequality of the moon; while Alpetragi, in his 'Planetarum Theorica' (a book translated by Michael the Scot, and referred to by Roger Bacon), proposes to supersede the Ptolemaic system by a theory of spirals, in some respects comparable to that of the "Thema Cœli." Alhazen seems to have made considerable progress in Optics, and Omar El Aalem to have been the first to devote a distinct treatise to the sea. On a freer field the Arabs made a more decided advance, which they turned to an important practical purpose in their schools of medicine. As early as the middle of the eighth century, Geber, who may be regarded as the father of chemistry, laid down the principle adopted by Bacon as the key to man's work as the minister of nature. The following sentence is one of the most striking, though perhaps the most neglected, of the anticipations in the history of thought: "Similiter et metalla non mutamus; sed natura, cui secundum artificium materiam præparamus: quoniam ipsa per se agit, non nos, nos vero administratores illius sumus." But Geber probably failed to follow his maxim to its consequences; and his true titles were soon obscured by the cloudy fame of supernatural power. After two dead centuries, chemistry was revived by Avicenna (978-1037), and associated

with the system by the exposition of which he, availing himself of their results, superseded Hippocrates and Galen. To this remarkable man, whose genius has been referred to as the most comprehensive of his nation, is in great measure due the canonisation of those Aristotelian studies initiated by Alfarabi of Bagdad, and the imposition of a new authority on the mind of ages ready to accept it. The reproach, as far as it is so, of living in an "age of Faith," of substituting quotation for thought, obedience for inquiry, applies to the Arabs equally with their foes on the field of arms and controversy: they had none of the modern progressive spirit, or the audacity of the Renaissance. On the side of religion, they were bound as strictly by the Koran as their Christian contemporaries by the creed of the Fathers. On the side of logic, they in a like spirit accepted Aristotle. There seems to have been in early Islam little trace even of the veiled protest that occasionally appears in the early ages of the Church. If there was any tendency in the East to the assertion of more real freedom for thought, it was, in the later years of the eleventh century, arrested by Algazel of Bagdad, who, after searching through the schools in vain for certitude, and finding reason as deceptive as the senses, fell back in despair on a view like that of Lactantius that philosophy was "the patriarch of all the heresies," wrote a treatise entitled 'Destructio Philosophorum,' and sought refuge in the sentimental inspiration and ascetic life of the Soufis. This reactionary influence was, in the next age, only partially counteracted by Averroès (1120-1190) the most noted of the Spanish Arabians, a physicist as well as a metaphysician, whose

efforts to defend and restore the Aristotelian methods—in his hands somewhat incongruously associated with Neo-Platonic emanations—appear to have met with a more favourable reception from Jews and Christians than from his own fellow-religionists.

The growth of Arabian [1] and of all mediæval science was retarded by timidity, and by the Mysticism that tends to recur in every age. Rooted in impatience of the slow methods of genuine research, the desire to find short cuts to great results, and the wish to enliven hard facts with a glow of feeling, it is most natural in the childhood of nations and of men, but it lingers in the manhood of both. Francis Bacon, in the midst of his constant protests against it, constantly lets us see its influence over a mind at every turn constrained to accept from the past a repudiated inheritance (*vide infra*). His own image of the early seekers after the philosopher's stone, the universal solvent, and the elixir vitæ, conveys a true criticism; in digging for gold they ploughed the land. But for centuries their work was marred, and its useful results retarded, by two causes. Ignorant of distinctions, they, in their premature desire for universal knowledge, confounded together even the shadows of science they were pursuing, mixed up fact and fable, mythology and meteorology, associated moral with physical qualities, sought for perfection among the metals, and a millennium in the discovery of their "magisteries." They found a mystic relation between gold and Apollo, silver and Diana, quicksilver and Mercury, iron and Mars,

[1] For a further account of the Arabian philosophy, *vide* Renan, 'Averroès et l'Averroïsme;' also Lewes, 'History of Philosophy,' vol. ii. pp. 38-62.

lead and Saturn, tin and the Devil, and, so, often merely sowed and reaped the air.

The other cause lay in the prejudice which the often pretentious claims of these erratic pioneers naturally excited in an ignorant age. The unripe fruit which they plucked from the tree of knowledge was regarded as forbidden, and hardly one among them escaped the charge,[1] sometimes followed by severe practical consequences, of unhallowed dealing in the black arts. It has been observed that in dark periods and among rude peoples superior powers are apt to be the butts of hatred and fear. On the minds of those assailed this had a twofold result; it led to the practice among the more cautious thinkers of expressing themselves in occult phrases, of conveying the secrets[2] of which they fancied themselves possessed, in enigmas intelligible only to an initiated few, thus restricting the range of their influence: it misled the more rash or daring into themselves believing or asserting the truth of the allegations against them. The same perverted pride which, in much later times, often brought reputed witches to the stake,

[1] Among the conspicuous reputed magicians of the dark and middle ages were Geber, Gerbert or Sylvester II., Grostête, Albertus Magnus, Arnold of Villanova, Raymond Lully, Roger Bacon, and Picus of Mirandola. Similarly Virgil is represented in the 'Gesta Romanorum' as a conjuror, and Thomas the Rhymer was accepted as a wizard.

[2] The interval between the twelfth and sixteenth centuries is studded with books of secrets—*e.g.*, Vincent de Beauvais's 'Speculum Quadruplex,' c. 1250, belonging to the next century, though even the 'Speculum Majus' was not published till 1473; Bartholomew Glanvill's 'Properties of Things'; Levinus Lemnius's 'De Miraculis Naturæ,' published c. 1600; the 'Bibliotheca Universalis' of Conrad Gesner, fl. 1516-1565; the works of Don Alessio Ruscelli and Polydore Vergil, fl. 1520; the 'Secreti Diversi' of G. Falloppio, c. 1550; and the 'Magia Naturalis' of Giambatista Porta, 1538-1615.

tempted men like Michael the Scot and Paracelsus to confess to the superhuman knowledge of which they were accused. When the accusation remained a mere popular cry, it might be despised; but when it was countenanced by authority, it became formidable.

Meanwhile the Church had made good its claim to be regarded as a patron of learning, though in bonds, by its part in the foundation of the universities, of which, in the twelfth and thirteenth centuries, those of Bologna, Paris, Oxford, Cambridge, and Padua were the chief, and by its countenance of the Scholastic Philosophy. Sir William Hamilton and German commentators have done something to realise the wish of Leibnitz for the extraction of the scattered particles of gold in abandoned mines; and Mr Maurice has warned us against contempt of those who, under fetters, yet ruled the serious thought of their time. But when due deference has been paid to the men on whose shoulders we are sometimes raised, we may still assert with Bacon that the schoolmen mistook subtilty for wisdom, and divided their ingenuity between questions impossible to answer, and others not worth raising.

Much that seems to us barbarous in their language, and futile in their distinctions, may have been due to a confused terminology not inconsistent with logical acuteness; but their fundamental error lay in an idea of Science more false than that of the ancients. The schoolmen were not a body held together by any community of sect: on the few open questions they were often ranged on different sides, but they were at one in worship of an authority which, having accepted, they were resolved to impose. In their age, it has been said,

"speculative men became tyrants without ceasing to be slaves; to the character of commentators they added that of dogmatists;" and they employed the exclusively deductive method that has been noted as marking a stationary period. Their psychology was crude, and in all their writing that in any way relates to physics, the human mind seems to be reacting its infancy. M. Cousin has drawn special attention to the theologic origin of their philosophy. Scholasticism, "the labour of thought in the service of faith," emerging out of mythology as Greek speculation emerged from mythology, had its origin under Charlemagne, who established in episcopal sees monasteries and convents, the schools out of which the thought of the age developed. Of this preliminary period, characterised by the influence of conceptions partially Platonic, Joannes Scotus struck the note in his dictum: "There are not two studies, one of philosophy the other of religion; true philosophy is true religion, and true religion true philosophy." But, as a recognised method, scholasticism more properly dates from the later years of the eleventh century, when William of Champeaux began to teach at Paris, and thereafter manifested itself in three main stages.

I. 1070-1200, when philosophy was still a mere adjunct of theology, and the more rigid of the churchmen, as St Bernard, opposed it. The considerable names of this era are those of Roscelin and Anselm, who, in starting the controversy of Nominalism and Realism, reopened the ever-recurring debate as to the relation of sense and ideas; of Abelard, illustrious by his popular eloquence and originality; and of Peter Lombard, who, in the 'Book of Sentences,' in which he laboured to recon-

cile the apparent contradictions of the Fathers, was regarded as the authoritative expositor of a distinct scholastic theory.

II. 1200-1300. This era is that of the dominance of Scholasticism, when philosophy and theology began to meet on more equal terms. It is marked by encyclopædic systems as imposing as the cathedrals under the shadow of which they grew, by the charters granted to the universities, and by the missionary zeal of the friars who, at its close, received their apotheosis in Dante's Paradise. Two of these—Thomas Aquinas the Dominican, and the Franciscan Duns Scotus—though agreed as advocates of Realism, were the protagonist disputants of their age. At a slightly earlier date, Albertus Magnus was among the first to vindicate the unwieldy genius of Germany by forty-one folios of multifarious erudition, in which he expounded Aristotle and Avicenna, and, in emulation of the former, tried to gather all knowledge into an organic whole. Like his model, he recognised Logic as a science of method distinct from Physics and Metaphysics; but while admitting that we must start from Physics, he made their study wholly subservient to the ontology which was to him, as to his compeers, the absorbing pursuit.

III. 1300-1450. In this era we have the beginning of a separation between dogmatism and inquiry, ending in the birth of modern philosophy. It is introduced by Occam, who, a pupil of Scotus, subsequently opposed his master's views, supplanting them by the modified form of Nominalism since generally accepted. He attacked "the representative theory" of perception, still held throughout the seventeenth century, and applying

his "razor,"—"entia non multiplicanda sunt præter necessitatem,"—logically cut the ground from the more fantastic forms of Realism. Though Scholasticism survived, according to some critics, till the death of Thomas à Kempis, it lingered only in decline after the invincible doctor had won his victory for the heterodox party in the Church. Occam was the last of the great schoolmen notable among them for his championship of the political against the ecclesiastic power, "Tu me defendas gladio ego te defendam calamo," which made him, like Wycliffe, his younger contemporary, in some degree a precursor of the Reformation.

During those periods of controversies so keen that they inflamed persecutions, about matters so trivial that they provoked the timid satirists of submissive times, the authority of the Church was divided with that of Aristotle: to men's prescribed relations to both might have been applied the motto, "credo ut intelligam"; and the revolution of thought that shook the one overthrew the other. This strange alliance between a form of Christianity which relied for the sanction of its decrees on the hopes and fears of another world, and a philosopher who, to all practical intents denied their validity, is a riddle that can only be resolved by reference to the dominating love of system in both of the contracting parties. For some time it met with a strenuous though intermittent resistance. The leading churchmen were at first suspicious of arguments which had, with equal emphasis, been employed in defence of the Koran; and their early attitude towards the Arabian gift was "Timeo Danaos"; but, in the thirteenth century, the Friars and their followers

agreed to baptise the reasoning they were unable to refute; and succeeded in conducting it, through adverse decrees of popes and councils, to an influence the latter were constrained to conciliate.[1] It is characteristic of the reverential attitude towards the ancient teacher that the earliest assailants of Scholasticism arraigned it, not on the ground of slavish adherence to his methods, but of misusing them. Thus John of Salisbury, though an admiring pupil of Abelard, sarcastically protests against the time wasted by his instructors on trivialities that "left him no wiser," and upbraids them for neglect of the demonstrative sciences—a neglect he attributes to the mistranslation of those parts of Aristotle's works that related to physics. The real cause lay in their being alien to the spirit of an age when it was possible for his contemporary, Peter of Blois, to define mathematicians as "those who, from the position of the stars, the aspect of the firmament, and the motions of the planets, discover things that are to come." Those early reclamations are interesting as unconsciously prophetic. Scholasticism bore somewhat the same relation to modern metaphysics that Alchemy did to Chemistry. The one opened the way for the other, and, amid many unprofitable disputes, started under the masks of grammar and

1 *Vide* Launoy on the "Various Fortunes of Aristotle in the University of Paris." In 1209 his works were prohibited on the ground of heresy; in 1215 his Logic was again publicly taught; in 1231 his Natural Philosophy and Metaphysics were proscribed by Gregory IX. In 1250 Frederick II. had several of his treatises translated from Greek and Arabic, and recommended to the University of Bologna. Albertus and Aquinas almost canonised him, and throughout the fourteenth and fifteenth centuries he remained supreme; and, in the sixteenth, Francis I. appointed judges to condemn Ramus for his assaults on the authorised Logic.

logic those great problems that still divide the followers of Descartes and of Locke. But this intellectual gladiatorship did nothing to dispel popular ignorance. The crowds that flocked to hang on the lips of Abelard, or to draw the triumphal car of Duns Scotus into Cologne, were, in practical matters, little instructed by being told that morality is in the intention, not the deed, or that an individual is Peter because his humanity is combined with Petreity. They left "none the wiser" for the weaving and unweaving of Penelope's web, the Lilliputian disputes about hœceity and quiddity, where Physic of Metaphysic begged defence in vain. The schoolmen were ambitious to construct a Cosmos, but they could only follow in the steps of predecessors as insensible as themselves to the need of experience and the uses of experiment. As early as the twelfth century, Richard of St Victor had declared, almost in the words of the 'New Organum,' that "Physical Science ascends from effects to causes, and descends from causes to effects;" but his mere declaration bore no fruit. Towards the close of the period Peter Lombard is no further advanced than St Augustine or Bede. The precession of ideas set forth by Aquinas is that of Plato, probably through Averroès; his six articles of corporeal action are *à priori* conclusions; the list of seven mechanical arts given by Bonaventura (1221-1274), though interesting, is empiric; the species of Scotus are transferred with little modification from the Peripatetics. The current opinions of an age when few laymen could read or write, were behind those of the contemporaries of Socrates. Most men who thought on the matter at all believed the

earth to be flat,[1] that there could be no antipodes because they would fall away, and that the heavens were sustained on a material floor. The elements of science imported from the East by Gerbert, Adelhard of Bath (the first European translator of Euclid), Kitello of Poland, who adopted the principles of Optics from Alhazen, and others, together with the numerous isolated inventions of the thirteenth century (as clocks, astrolabes, and the mariner's compass), but slightly affected the prevailing ignorance. Nor were the Arts in which the age excelled of more avail; for, as in Greece, they were divorced from theory, and perhaps the noblest structures that have been reared in stone were put together without a knowledge of the first principles of mechanics. While the façades of Amiens and Cologne were being carved, and the minster towers of Ely built, and the foundations of the Duomo at Florence laid, the masters of the guild, whose work is still the wonder of the world, were being instructed in Aristotelian phrase that "gravity is a motive quality arising from density and bulk, by which the elements are carried down," and that "the moistness of water is controlled by its coldness, so that it is less than the moistness of air."

[1] There are a few traces of more advanced views—*e.g.*, Dr Whewell instances a work of the reign of Edward II., the 'Ymage du Monde,' which, versifying the Ptolemaic system, represents the earth as a round body from whose circumference figures are dropping balls that meet in the centre. He compares with this Dante's account of the passage from the bottom of the abyss where Lucifer is seen with legs reversed, and the explanation that follows :—

> "Thou didst surpass
> That point from which to every point is dragged
> All heavy substance."

The few encyclopædic writings of those ages in which keen-eyed antiquarians find foreshadowings of physical discovery,—notably the famous 'Speculum' (naturale, morale, doctrinale, et historicale) of Vincent de Beauvais, a heterogeneous mass of learning and superstition, remained for long either unpublished or practically inaccessible; while the universities were (with the exception of Bologna devoted to Law, and Montpellier to Medicine) almost wholly scholastic. Their teachers left the mass of their pupils as Chaucer describes them; they canonised Duns Scotus and banished Roger Bacon; their care was not to find but to decree; less to prove than to assert. Whetstones of logical razors, they thought little of the ends on which Francis Bacon, perhaps in his turn too exclusively, insists. They regarded mundane researches as the "dim uncertain lights" of the 'Religio Laici'—

"Inque domos superas scandere cura fuit."

CHAPTER IV.

THE MIDDLE AGE.

Long unfulfilled reforms have not unfrequently been, in outline, prophesied by exceptional thinkers, formally belonging to sects in the main conservative—thinkers of whom Roger Bacon of Ilchester (1214-1292) is a conspicuous type. This illustrious man, the most enlightened, before Leonardo da Vinci, among the intellectual predecessors of a namesake from whom he received scant justice,[1] was a Franciscan friar, regarded as the Doctor Mirabilis of the age, to whose obscurantist zeal his work was largely sacrificed. But he had no sympathy with the methods of his fellows, and, save in a few relics of superstition, no communion with their prejudices. A Schoolman merely in name, he was as distinctly the first considerable physicist as Dante was the first great poet, or Petrarch the first highly cultured critic of modern Europe. This relation to the future herald of inductive science has been compared to that which, a century

[1] Mr Ellis doubts if Francis had seen the 'Opus Majus.' We leave our readers, on any other hypothesis, to explain the coincidences between it and the 'Novum Organum.'

later, Wycliffe bore to Luther, and some of his positive attainments were further in advance of his time than those of his great successor. He was, by all accounts, a fair Greek and Arabic scholar, while the barbarity of his Latin was shared by his contemporaries.

A theoretical musician, geometrician, and geographer,[1] he stumbled upon many of the leading laws of optics, astronomy, chemistry, and mechanics, and his safe reputation for logical acumen was only eclipsed by the dangerous fame of his inventions.[2] Roger Bacon, as a philosophical experimentalist, was an almost solitary "bee" among "spiders and ants"; but he is still more remarkable as the first who recorded the modes of legitimate investigation in the realm of nature. His great inauguration of reform, the 'Opus Majus,'[3] the record of a design to lay down the lines of a new "Ratio inveniendi," abounds in anticipations of the 'Novum Organum.'

[1] Mr Spedding has called attention to the interesting fact that Pedro de Alliaco, in the 'Imago Mundi' (A.D. 1410), translated a passage from Roger Bacon suggesting the possibility of reaching to the Indies by sailing to the west. Columbus is known to have been familiar with this book, and impressed by it.

[2] Dr Whewell enumerates among these the invention of gunpowder (though an earlier reference to it has been supposed to be made in an Arab MS. of A.D. 1249, and it is elsewhere attributed to a German monk, Berthold Schwartz, 1320), of an improved clock, of lenses and burning-glasses, and a telescope. The last is, however, doubted by Hallam. Bacon also corrected the calendar, and gave an account of the source of the colours, form, and apparent position of the rainbow, arriving at his result by an early use of the methods of agreement and difference, characterised by Whewell as "a most happy example of experimental inquiry into nature."

[3] This work was dedicated to the author's patron, Gregory IV., and sent, by request, to the Pontiff on his accession, which fixes its date 1265. It remained unpublished till 1733, but was widely circulated in MS.

In both works there is the same exposition of the causes of error in the past, the same exhortation to rely on experience and experiment, the same faith in the future of science,[1] the same attempt to illustrate precept by example, and a like blending of confidence and humility, the latter perhaps finding a finer expression in the words of the elder writer: "Man is incapable of perfect wisdom; . . . let him not boast or extol his knowledge. What he knows is little to what he takes on credit, less to that of which he is ignorant. He is mad who thinks highly of his wisdom, most mad who vaunts it as a wonder."

Part I. of the 'Opus Majus,' setting forth the four sources of ignorance—the irrational sway of unverified authority, the force of custom and habit, the opinion that is misguided by mere sense-impressions, and the false pride of fancied omniscience—nearly corresponds to the treatment of the "Idola Theatri," "Specus," and "Tribus" in the 'Organum.' The "Idola Fori" are the theme of Part III., which, devoted to the study of language as "one of the roots of knowledge," handles the question, especially in reference to derivations and combinations of words, in a manner that, according to Professor Max Müller, does honour to the philology of the 13th century. Roger Bacon is more rarely than Francis led astray by verbal ambiguities, and his etymologies are generally more correct. In Part IV. of his book, devoted to mathematics, he shows his

[1] "The later men are, the more enlightened they are; and wise men now are ignorant of much the world will some day know," is Roger Bacon's equivalent for, "The old age is the youth of the world."

greater familiarity[1] with that "door and key of the sciences," and a better appreciation of the part it had to play in advancing as well as formulating discovery. Part V. is a dissertation on Optics, in which the phenomena of reflection and refraction are clearly stated, and the theory of the transmission of light and heat by species, in which Bacon may have been confirmed by his studies of Avicenna, is adopted. Part VI., the final section of the work, is devoted to an exaltation of "Experimental Science," which, using a term familiar to readers of Book II. of the later 'Organum,' has, he announces, three *Prerogatives:* 1. It tests the conclusions of observation, as illustrated by his analysis of the phenomena of the rainbow; 2. It makes discoveries which the other sciences cannot arrive at unaided, under which head, showing himself still affected by the traditions of Alchemy, he brings the arts of prolonging life and of making gold; 3. It, by its own power, displays the secrets of nature.

A remarkable feature of the 'Opus Majus' is the space devoted to a sketch, in the spirit of more recent times, of the progress of early speculation from Thales to Aristotle. In his references to the last, Roger Bacon again suggests a comparison with Francis by his apparent inconsistency. Toward the end of the historical survey, he treats his predecessor with even more than the respect accorded to him in the 'De Augmentis,' regretting the period during which his works were buried,

[1] All science, he contends, requires mathematics, which, being the simplest and most certain, engaged in a sphere where γνωριμώτερα φύσει are also γνωριμώτερα ἡμῖν, and intuitively apprehended, is properly prior to those more complex and difficult. Cf. Comte's Classification of the Sciences.

before their resuscitation by the Arabians: but he protests against his decisions being final; and, in the course of the discussion on language, expresses himself with a vehemence equal to that of the 'Temporis Partus Masculus.' "Si haberem potestatem supra libros Aristotelis, ego facerem omnes cremari: quia non est nisi temporis amissio studere in illis." That this, however, is rather a protest against the bad translations of "the philosopher" than a judgment on his work, appears from a passage at the close, declaring that, "as Aristotle by his wisdom gave Alexander[1] the kingdom of the world, so if prelates and princes would encourage study, and join in searching out the secrets of nature and art, the Church would be able more readily to triumph over Antichrist." The glory of God and the advancement of man's estate are set together as the goals of the new road from a new starting-point in the 'Opus Majus' (the second part of which is devoted to the sacred sources of wisdom), as in the 'Instauratio Magna.'

Devout aspirations are no safeguard against the risks of enlightenment in an unenlightened age. Roger Bacon was the first in modern, as Anaxagoras in ancient times, to be publicly prosecuted for a philosophic heresy.[2] In both instances the attack may have been urged by political causes. The Greek, it is said, was accused of Medism; the English friar had abetted his friend Bishop Grostête, in resistance to the extortions of

[1] Aristotle and Galen are similarly compared to Alexander in a posthumous work of William Gilbert (1603), who thus handed on the image to Francis Bacon.

[2] The martyrdom of Hypatia was an assassination by a mob led by a fanatic, and that of Boethius was wholly political.

Innocent IV. But both assaults protest against physical explanations of phenomena hitherto cherished as supernatural. The ancient and modern thinker alike affronted prejudice in a matter which could be understood. When Parmenides summed his view of the material world in "seeming, seeming," the masses—

"κωφοὶ δμῶς τυφλοί τε τεθέποτες ἀκρίτα φῦλα"—

remained as indifferent as they afterwards were to the disputes between the Thomists and Scotists; but when Anaxagoras ventured to refer Jupiter's bolts to the friction of the clouds, or the elder Bacon, four centuries too soon, to suggest an imitation of thunder, the one was arraigned for impiety, and the other denounced as a magician. Rumours, set afloat it may be by jealousy, were accepted by ignorance, — that strange noises were heard in the laboratory at Oxford, that it was haunted by evil spirits, that the chemist had sold himself for the gold of which he professed to have the secret. His books were prohibited, and he was himself thrown into prison,—"incarceratus sum," he quaintly remarks, "propter incredibilem stultitiam eorum cum quibus agere habui,"—where he seems to have lingered several years, till influential intercession obtained his release. Bacon was encouraged by the countenance of Clement IV.; but, on the death of that potentate, there was no one left able or bold enough to recognise the importance of his investigations, and the good seed fell among sand or was choked by thorns. Perhaps the most accurate of all the anticipations in the history of scientific method had no permanent influence on an age of clouds too dark to be pierced by the

"lucida tela dici"; and the 'Opus Majus' had to give way to the 'Summa Theologiæ.' The fate of their authors in the memories of men and in literature is curiously contrasted. The Master Scholiast is enshrined in the 'Divina Commedia' as the foremost of the lambs of Dominic; the real discoverer was as late as the close of the sixteenth century classed, in the farce of Greene, with Friar Bungay, as a vulgar necromancer.

Another name of nearly the same age appears with a more shadowy renown. While Roger Bacon was a student at Oxford, MICHAEL THE SCOT was prosecuting, with only inferior success, similar researches at the Court of Frederick II. Especially distinguished in natural history, he translated Aristotle's works in that department, and was celebrated for his skill in Astronomy and Medicine; but he mixed up those true sciences with their mirages, Astrology and Alchemy, and his fame as a sorcerer has obscured his reputation in philosophy. At a slightly later date, in the south of Europe, ARNOLD OF VILLANOVA became known for a wide miscellaneous learning, and speculations associated with his medical pursuits: while RAYMOND LULLY, a native of Majorca, set forth a new system of acquiring and arranging knowledge that obtained for its author a scarcely merited celebrity. This once notorious mystic, wanderer, and charlatan, claims mention as having, with a glimmer of the Renaissance spirit, ventured to question the authorised methods of his age; but he offered nothing substantial in their place. The 'Ars Magna,' revealed to him in answer to prayers addressed to heaven in a crisis of revulsion from a dissolute life, is rather the record of a new excitement, made attractive by the im-

aginative audacity of a vague ambition, than a rational system. The illumination of Lully is like that of the Neo-Platonists, but more superficial. His universals are assumed: *e.g.*, he asserts that the Predicables and Categories came to him by inspiration in a ray out of chaos, and from these he draws, by a purely geometrical method, his few intelligible conclusions. He seems to have taken his Cabbalism from the Arabians, whom he proposed to convert; while his tables and trees of science are mere catalogues of previous facts or fancies recombined by a mechanical process. Leibnitz says his manner of using machinery for mental labour might be convenient in speaking from shorthand notes; but it suggests the devices of the philosophers of Laputa rather than the formally accurate grinding organs of Mr Jevons. Francis Bacon may have been unconsciously influenced by the now long-forgotten fame of the 'Great Art' in his scheme of ciphers to represent thoughts and things; but he repudiates Lully's fancy that real knowledge can be attained by logical legerdemain, and condemns his system in one of his justest censures as "a method of imposture," which "scatters about little drops of science in such a manner that a smatterer may make ostentatious use of them with a certain show of learning. . . . The art of Lully consisted in nothing but a mass and heap of the words of each science. . . . Such collections are like a rag-shop, where you find a patch of everything, with nothing that is of any value." This Neo-Spanish mystic dogmatism, in spirit and method, had many aftermaths in the fifteenth, sixteenth, and even seventeenth centuries, but with Raymond Lully the early reforming movement of the thirteenth may be said to have set in clouds.

The flower seasons of literature are not always identical with those of the fruitage of science. The fourteenth century, the age of Petrarch, Boccaccio, and Chaucer, was rife not only in material but in mental wars; it was the age of the great English victories over France, of Rienzi, of the early prime of the Venetian and Florentine republics, of the Lollard forecast of the Reformation, of the insurrections of the Jacquerie and Tyler—ominous though far foreshadows of the Revolution,—and of the Schism in the Papacy, from the results of which the temporal power of St Peter's never wholly recovered. But this period is the dead age of science. For more than a hundred years nothing was done, or even suggested, to forward any branch of physical research, and the solitary advances in man's knowledge of the external world were the often challenged reports of the travellers Marco Polo and Mandeville. The ban upon Roger Bacon's books seems to have imposed itself on all Europe during the whole of this interval of reaction, and men turned back from experiment to reasoning and Aristotle. The darkness was first broken by a cluster rather than a series of events which, in the middle of the fifteenth century, acted in concert to stir as well as to widen the minds of men. The same year, 1453, saw the expulsion of the English from France, the capture of Constantinople by the Turks, and the publication of the Mazarin Bible. The first event, the final close of harassing wars that had absorbed the energies of two nations, left each more free to develop its own material and intellectual resources. The art of Printing opened a new world, multiplying a hundredfold memories of the past and hopes for the

future. The surveillance which the hierarchy, even under so enlightened a Pope as Nicholas V., still imposed on books was gradually relaxed, and in the later years of the century the weapons were forged that were wielded in the strife of the Reformation, while the postulates of the sciences were revised, and their foundations relaid on firmer bases. The result of the siege of Constantinople, dispersing the remnants of the Greeks, brought into Western Europe, through Italy, a new class of ideas. Scholasticism proper was in its death-throes; but Aristotle, more correctly understood, still held sway over thought, when newly revived studies opposed a rival authority, that of the whole range of the classics. "A spark of freedom," says Gibbon, "was produced by this collision of adverse servitude." The first stages of the revival of Platonism did comparatively little for the instauration of science, which remained in abeyance to the cultivation of the Arts, fostered by the free activity of the small Italian States. A protest against bad style took precedence of the protest against false methods; but the spirit of revolt in the air soon began to show itself in definite results. Nicholas of Cusa on the Moselle (1401-1464), a Cardinal of the Church, was the first of his age to oppose to the Aristotelian dogmatism the Socratic *γνῶθι σεαυτόν*, as a point of departure for a new Platonic synthesis. The following sentence from his 'De Doctâ Ignorantiâ' again takes up the thread of the 'Opus Majus': "If the case be so—that in things most manifest by nature there is a difficulty, no less than for an owl to look at the sun; since the appetite of knowledge is not implanted in us in vain, we

ought to desire to know that we are ignorant. Attaining to this, we arrive at *instructed ignorance.*"

This writer is the earliest modern who distinctly records his adherence to the heliocentric theory, and asserts, without qualification, the motion of the earth: "Jam nobis manifestum est terram in veritate moveri." But it was an assertion without the proof of Copernicus, another hypothesis opposed to that of Hipparchus. The humanists, as well as the schoolmen, had their pedantry, but it was more elastic; and the form of the dialogue into which their discussions were thrown gave more opening to the presentation of various views. Among the authors of an age of various activities, Leo Baptista Alberti (1404-1472), painter, sculptor, architect, and optician, endeavoured in his works, theoretic and practical, to promote the interests of a wide-ranging culture; while Laurentius Valla, classic and critic, led the assault against Aristotle. During the same period (when the surge of Nominalism and Realism was still seething, and Louis XI. of France felt called on to take a side in the controversy), Rudolph Agricola (1443-1485) was endeavouring to perform the same service for Germany; while Joannes Muller of Konigsberg[1] (Regiomontanus) made more definite contributions to science (1436-1476) by the advancement of Trigonometry, and a more accurate registration of the positions of the sun and moon.

Meanwhile the "Platonic Academy," founded at Florence by Cosmo and matured by Lorenzo de Medici, gave the impulse of a central authority to studies, the results of which Marsilius Ficinus (1433-1499), court translator and commentator, helped to diffuse. His

[1] Muller also adopted the view of the earth's motion.

rendering of Plato is generally accurate and in good Latin. The same judgment has been passed on the contemporary version of Aristotle's 'Physics' by HERMOLAUS BARBARUS[1] (1454-1495), a student of philosophy and science, who is, however, mainly remembered as the legislator of his age in matters of style. The philosophy of Ficinus is eclectic and mystical, and, in the manner of his time, he attempted in his work, 'De Concordia Platonis et Aristotelis,' to reconcile incongruities; blending the arcana of the Cabbala with the illuminations of Plotinus and the emanations of Averroès, though he diverged from the last in his vindication of the doctrine of personal immortality. The love of mystery[2] which pervaded this and a later period (popularly represented in the plays now beginning to prelude the rise of the regular drama), finds expression, side by side with traces of a more scientific spirit, in several encyclopædic thinkers and investigators of the century—as Purbach, Ripley, Bartholomew Glanvill, and the shadowy figure of Basil Valentine, reputed discoverer of antimony,—at once alchemists and genuine chemists, whose works (despite the fantasies by which they are partially obscured) are important links in the history of mental and material progress.

The influence of those thinkers, conspicuously of Ficinus, is manifest in the youthful and versatile genius of

[1] H. Barbarus seems to have been the first (*vide* his controversy with John Picus of Mirandola) to express disgust at the Latin of the schoolmen. His proposal to establish an *artistic censorship* of books is in our days worthy of consideration.

[2] For a concise statement of the main forms which this exhibited at the close of the middle ages, *vide* Hallam, 'Lit. of Europe,' vol. i. pp. 199-202.

John Picus of Mirandola (1463-1494). To a precocious knowledge of languages he added a familiarity with the learning of the schools, as then taught in the Italian and French Universities, that emboldened him in 1486 to maintain nine hundred theses on all known questions, "mathematical, physical, magical, and cabbalistical," in the manner of the Aristotelian wit-combats, in which students of the church and law were still exercised. But the spirit of his philosophy is Neo-Platonic. In anticipation of Bacon's 'De Sapientiâ Veterum,' his habit of reading allegories into the Scriptures, and searching for hidden meanings in other real or spurious sacred books, set a fashion of interpretation not wholly extinct; and he allowed himself to be persuaded that the remote Greeks, as well as the Hebrews, shadowed forth recondite truths under the veil of mythological fancies. With him Cadmus, Medea, and Jason, Danae, Ganymede, and Dædalus, the Sphinx and the Chimæra, were types of modern discoveries and research, as palpable as the "types" of Gospel history in the Old Testament. Picus is associated with the alchemists by the fact of his having written a treatise on gold. Referring to his reputation among his contemporaries, a generally severe modern critic admits that he was justly regarded as the phœnix of his age; but his range in fields of knowledge so various was in excess of his originality in any, for to no branch of Science has he made any distinct contribution.

A longer life had already, at the date of Mirandola's death, made manifest the greater powers of the man whose name is by universal consent the foremost of the fifteenth century. Leonardo da Vinci has long

been recognised as the rival of Michael Angelo and Raphael. It is only of recent years that the publication of his writings has made him known as at once a theoretical reformer and a practical man of science. "These writings," says Mr Hallam, "according at least to our estimate of the age in which he lived, are more like revelations of physical truths vouchsafed to a single mind than the superstructure of its reasoning upon any established basis. The discoveries[1] which made Galileo, and Kepler, and Mæstlin, and Maurolycus, and Castelli, and other names illustrious, the system of Copernicus, the very theories of recent geologers, are anticipated by Da Vinci within the compass of a few

[1] Among these discoveries his Italian editor Venturi refers to the attainment, and in most instances the establishment by proof, of correct theories (*a*) in Mechanics, of — the equilibrium of the lever under the action of oblique forces; friction and resistance; the influence of gravity on bodies in repose and motion; the descent and ascent of bodies on inclined planes; the relation of initial force to speed, and of the motor power of machines to the weight of the bodies moved: (*b*) in Optics—the camera obscura; the laws of perspective; the nature of coloured shadows; the figure of light from the sun (which, *vide ante*, baffled Aristotle, and was afterwards explained by Maurolycus); the movements of the iris, and the duration of visual impressions: (*c*) in Hydraulics, he anticipated the observations of the astronomer Castelli on moving waters: and (*d*) in atmospheric Chemistry demonstrated that respirable air must support flame: (*e*) in Astronomy, he distinctly assumes (in a treatise of 1510) the annual rotation of the earth, and refers to it as a common opinion of his time; he found before Mæstlin that the obscure light of the unilluminated part of the moon is due to the reflection of the earth, and knew of the elevation of the equatorial above the polar waters: (*f*) In Geology he had advanced so far as not only to assert, but, on grounds of modern reasoning, to demonstrate, that the sea had once covered the tops of mountains on which shells had been discovered. Leonardo, theoretically as well as practically, understood and wrote well on fortification, architecture, and the art of painting.

pages—not, perhaps, in the most precise language, or on the most conclusive reasoning, but so as to strike us with something like the awe of preternatural knowledge." But it concerns us most that he, more distinctly even than Roger Bacon, enunciated the views of the 'Instauratio Magna' as to the proper method to be followed in the investigation of nature, and the importance assigned to its results. The force and application of the following dicta, with numerous others to the same effect, are unmistakable :—

"My design is first to examine facts, and afterwards to demonstrate how bodies are constrained to act. It is the method one must adhere to in all research into Nature. . . . True, she begins from Reason and ends in Experience ; we must begin with Experiment, and try to discover the Reason."

"The interpreter of the artifices of Nature is Experience : she is never deceived ; it is our judgment that is led astray by imagining unreal effects. We must scrutinise phenomena and vary their circumstances, that we may elicit rules to direct our speculation in Science, and control our practice in Art principles which will prevent us from promising unattainable results. Those who consult authorities instead of Nature are not her children, but at best the grandchildren of her who is the sole mistress of true spirits ; while the foolish masses mock at the men who would rather learn directly at her knees than consult her clerks."

"It is right for the understanding to acquire knowledge, whatever it be ; one may then choose the good and reject the useless."

It is hardly possible for words to come nearer the most impressive passages of the 'Novum Organum.' Da Vinci, more distinctly than Bacon, realised the importance of mathematics in discovery, declaring that there is

no certainty in sciences where they cannot be applied: he more clearly understood the interdependence of ideas and observation, saying, "Theory is the general, experiments are the soldiers." As an architect, engineer, and optician, he put into practice his precepts, and in doing so, learnt to combine caution with confidence in his forecasts. But he lived in a less propitious age:[1] amid the greatest galaxy of artists indeed that the world had seen, he yet, as a patient philosopher of Nature, stood almost as much alone as Roger Bacon had done before him. Art had only begun to give a stimulus to science, and the theoretic and practical powers combined in Leonardo remained for another hundred years comparatively apart.

1 The fact that none of his works were published till a century after his death is significant.

CHAPTER V.

THE RENAISSANCE.

The landing of Columbus at St Salvador in 1492, and the expulsion in the same year of the Moors from Grenada, with the invasion of Italy (1494) by Charles VIII. of France, and the establishment of our Tudor dynasty (1495) on the field of Bosworth, mark the close of the middle age. The Renaissance,[1] which followed close on those events, as a protest of the mind against centuries of vassalage, struck a blow at the shackles of superstition, which no Jesuit or Puritan reaction availed to fend; but the leaders of the movement (unless we include among them Da Vinci) contributed little to the progress of physical science, while the menace of the Reformation[1] made the Church even less tolerant, at the close than at the beginning of the era, to new phases of thought. The change is nowhere more marked than in the earlier and later reception given to the Copernican system.

Nicolas Copernicus (1473-1543) himself is remarkable for the caution with which he first put forth his

[1] As regards the relation to each other of these movements, *vide* vol. i. pp. 9-14.

treatise on 'The Revolutions of the Heavenly Bodies,' merely as "an hypothesis for their better explanation." Quoting from Ptolemy the maxim, "He who is to follow philosophy must be a free man," this Polish Catholic canon and prebendary yet ventured to publish only in the year of his death, on the urgency of Cardinal Schomberg, a discovery that he had made thirty-five years before. The book containing it had, however, been written in 1539, and the MS., which had a considerable circulation, roused the enthusiasm of Dr Vogelinus of Constance, who proclaimed it to be a Palingenesia or new birth. Copernicus is one of the numerous great men whose fame has elevated a scientific doctrine into an article of faith; and the acceptance of his views has been made almost a test of sanity, by critics in whose eyes their rejection has condemned the whole philosophy of Francis Bacon to contempt.

Copernicus, as we have seen, started no new idea: his unquestioned merit, his inalienable claim as one of the Fathers of Astronomy, rests on his having shown to be true that which the shrewdest of his predecessors had merely guessed. An observer only second to Tycho Brahe, and a mathematician whose accuracy has seldom been surpassed, he demonstrated, by reasoning on the relations of space and time, the rotations of the earth, as the captains of Magellan demonstrated its rotundity by sailing round it. Previous to his time, the rival solutions of the same phenomena rested on almost equal grounds. That of the Pythagoreans, followed by Aristarchus, relied on greater simplicity; that of Hipparchus was so much the more obvious that it has to this day the support of common language, poetic tradition,

and ignorant belief. Copernicus added weight to the argument in favour of simplicity, by dispensing with eleven of the Ptolemaic motions; but his theory was still inadequate. Adhering to the postulate of circular motion, he had to retain the eccentrics and epicycles, only lessening their number by translation into the language of another centre.

For fifty years after the promulgation of the new system, the question between it and the old was regarded as open, and for a century after, eminent men ranged themselves on either side. The Prutenic Tables were constructed on the authority of Copernicus by his disciples Rhæticus and Reinhold. Another, Wursticus, handed on his master's view to Giordano Bruno, who set it in the front of his "Nolan" philosophy. The Venetian Benedetti (1530-1590), who first clearly refuted Aristotle's mechanics, remarks that "the enormous velocity of the heavenly bodies, if the earth be the centre, is a difficulty which does not occur according to the beautiful theory of the Samian Aristarchus, expounded in a divine manner by Nicolas Copernicus." Campanella is equally positive. Kepler received the new views, disallowed by his master Tycho, from his first teacher, Mæstlin. On the other hand, Maurolycus of Messina (1494-1575) protests, "To amend the errors of all who have preceded us would be a task too hard for Atlas. Even Copernicus is tolerated, who makes the sun to be fixed, and the earth to move round it in a circle; and who is more worthy of a whip or scourge than a refutation." Similarly Jean Bodin (1530-1596) in his 'De Republicâ' "declares that the events of the world are determined by planetary influences, and that

the hypothesis of Copernicus is contrary to theology, sense, and science." The Protestants generally accepted the heliocentric view, with a faith that helped to incite the persecution of Galileo, the main count of whose accusation was his advocacy of "the Pythagorean heresy"; but only towards the middle of the seventeenth century was the system established as a popular creed.

At an earlier date, in Italy itself, the Church had to reckon with a group of writers who, it may be unconscious maskers, were undermining what they did not venture, perhaps even mentally, to assail, by the avowal of the dangerous, because in the long-run either revolutionary or reactionary, view — that what is contrary to Reason may still be accepted as true by Faith. This tribute of Science to Authority — often sincerely paid by minds conscientiously admitting a gulf between their respective spheres — is a mode of argument which, though half countenanced by Plato himself in passages of his 'Laws,' sustains the assertion of Hume that thorough-going scepticism is often the portal to implicit credence. Represented in modern times by numerous thinkers of eminence, from the Arabian Algazel to Cardinal Newman, this mode of arguing found, during the later years of the fifteenth century, its most conspicuous advocate in Pietro Pomponazzi, to whom so many suggestions of the philosophy of Bacon have been assigned by some recent critics, that it is proper, even in this rapid sketch, to note some of their points of comparison and difference. The once famous Italian, whose sympathy with so many of our still haunting perplexities makes the recent

neglect of him strange, was born at Mantua in 1462, and an early student of the Averroist Achillini. Subsequently, as professor at Padua, and then at Bologna —centres of the speculative materialism of the age— his eloquence attracted audiences (among his pupils being the elder Scaliger) almost as enthusiastic as those of Abelard. Pomponazzi was, in philosophy, so loyal a follower of Aristotle, that he compared his assailants to fleas on an elephant; but he clearly perceived the impossibility of reconciling his views with those of the Church, and was driven to assign to each a distinct domain. In his celebrated treatise 'Dell' Anima,' he admits that, according to his master and to reason, the soul, ψύχη, is mortal. It cannot exist without a body; the mover must have something to move, the form something to form; as the human intelligence must attach itself to images formed by sense, and the will has to act through corporeal agents. But there may be a universal soul, νοῦς, in the stars, though the vital principles of vegetable and animal grow and decay, and cease with the frames in which they are set. The question is one which Reason cannot settle, and to which the Gospels and the Church can alone give an answer. To these he therefore returns in the spirit of a filial submission. "It suffices that St Augustine, who is more than Plato or Aristotle, has believed in immortality, for me to add my faith to his." In like manner he treats the problem of free-will and destiny in the spirit of a trenchant scepticism that, piercing through shallow solutions, goes to the heart of the matter, alleging that, if man is free, something escapes Providence. So, on the origin of evil, he asks, "Why

does God not deliver man from his imperfections? If it is a sin in man to err, why is it not a sin in an Omnipotent Being to surround with temptations his feeble will, and in a world where the wicked, as a rule, make the best of it? His intelligence inclines to the doctrine of the Stoics, that the perfection of the whole makes all contrasts necessary, and that evil is in a sense good, an energetic element of progress; but he reverts to his rubric, "I believe as a Christian what I cannot as a philosopher." Pomponazzi, whose concessions, sincere or feigned, did not save him from the denunciation of monks and friars, or his books at Venice from being burnt by the jailer, is a Baconian in this severance of revelation from the light of Nature, as in his preference of sense to ideas, his views of miracles, divination, and "natural magic," his maxim that when Reason fails we must go to Nature for truth, in his belief in progress, and his assertion that initial doubt is the start of the development of science, carried so far as to admit that even religions change; but his distinction between the speculative and practical Reason, the last alone essential to common life, is more in the manner of Kant.

Meanwhile, during the first half of the sixteenth century, the Platonism of the Renaissance was losing itself in clouds. Of the mystics of this age of ferment and vague ambitions who exceeded the rest in celebrity, the earliest in date was Cornelius Agrippa of Cologne (1487-1535), a reputed wizard, according to Hallam, "one of those ephemeral demagogues who rise on the ruins of a throne," noted for attacking without understanding Aristotle. His main work, 'De Incertitudine et Vanitate

Scientiarum,'[1] by the author's own confession, inspired by jealous vanity, propounds a system of a threefold world—elemental, intellectual, and celestial—in which ideal archetypes, the wonders of the Magi and witchcraft, have a prominent part. He is interesting as the immediate forerunner of a more considerable man open to a like criticism. The eccentric career of AUREOLUS PARACELSUS (1493-1541) lies without our review. As an experimentalist he did substantial service to his science, inventing new analytical processes in chemistry, and directing attention to its actions in the animal functions (*e.g.*, he detected the calc of disease fancifully called Tartarus—hence Tartar—and called the fermentation of fluids gas); as a physician he was noted for pathological skill; as either an impostor[2] or a fanatic he pretended to impossible feats. His system is a medley of acute guesses and crude symbolism, founded on his dogma of salt, sulphur, and mercury (by which he replaced the four elements) in the external world, corresponding to the body, spirit, and soul in man. Assailing the old Alchemists, he is of their sect; one of the last adherents to the belief in the universal solvent, the transmutation of metals, and the elixir vitæ. In theosophy—*i.e.*, his faith in the direct sway of spiritual beings, gnomes, sylphs, pigmies, and the astral element in the human frame, over thought and life—he was a mystic of the mystics; and, despite his avowed reliance on sacred writings, his assertion that everything in the world is animated makes him rank

[1] This book, from which Bacon borrows in the 'Advancement of Learning,' is highly commended by German critics.

[2] *Vide* Browning's poem, the theme of which is the tragedy of a man of genius becoming a quack to humour the impatience of his audience.

with the pantheistic Platonists. Paracelsus was among the Alchemists what Abelard was among the Schoolmen, "vox satis vocalis," the most eloquent voice. Constant though hostile references to his pseudo-science and nebulous conceptions are scattered through the philosophical works of Bacon.[1] Among his direct successors we need only mention Robert Fludd (1574-1637), "the most

[1] As we have seen, Paracelsus is violently attacked in the 'Temporis Partus Masculus' as worthy of imprisonment for his ostentatious audacity; and the chemists, "benumbed by its glamour," are warned not to expect a complete tragedy from an ass that happens to have scribbled with its hoofs an A on the sand. Similarly, in the course of the same diatribe, Bacon commends a certain Danish doctor, Petrus Severinus (1542-1602), of whom little but the title of his work, 'Idea Medicinæ Philosophicæ,' is known, for having made musical the brayings of his master. More seriously or maturely, under the head of "Prerogatives of Motion" (Nov. Org., ii.), objection is taken to the Paracelsian triad; and in the 'Historia Ventorum' its deviser is ridiculed for "seeking a place for his three principles even in the Temple of Juno—that is, the air—and restricting the winds to Auster (the South), Mercury, Zephyr (the West), Sulphur, and Boreas (the North), Salt, omitting the baleful Eurus." In another criticism of the 'Organum,' where Bacon says that in his theory of alimentation by separation—*i.e.*, that the component parts of the human body are derived from corresponding elements in the food,—Paracelsus "delirare juvat,"—the latter has been shown to be essentially correct. In the 'De Augmentis' the author more reasonably protests against the notion of the Alchemists that there are to be found in men's bodies parallels which have respect to stars, minerals, and planets, as a misapplication of the emblem of the microcosm. Elsewhere (De Aug., B. ix.) Bacon inveighs against the mystic superstition of deriving all other philosophy from sacred works; adding, "This distemper has grown up in the school of Paracelsus and others, but the beginning came from the Rabbis and the Cabbalists." In the remarkable "Tenth Century" of the 'Sylva Sylvarum' on the Force of Imagination, he writes: "Some held that if the spirit of man gave a touch to the spirit of the world it might command nature: Paracelsus and some darksome authors of magic do ascribe to imagination exalted the power of wonder-working faith," which he characterises as "bottomless folly."

learned of the Cabbalists," who brought his views of the Macrocosm and Microcosm, of the identity of physical and spiritual truths, into closer connection with Mosaic traditions;[1] and Jacob Boehmen, in whose 'Aurora' many subtle moral intuitions are shrouded by the visions and emanations that affected the later and often similar speculations of Swedenborg.

The mystic method of interpretation infected even some of the more exact scientific thinkers of the century—as JEROME CARDAN (rival of N. Tartaglia as the founder of the higher algebra, and a noted assailant of Aristotle;[2]) and GEORGE AGRICOLA of Saxony, the first modern mineralogist, whose investigations were still confused by alchemy and a belief, long lingering in popular legends, in goblins of the mines. It appears even in the titles of such miscellaneous collections of facts and fancies as the 'De Miraculis' of Levinus Lemnius, and Giambattista Porta's[3] 'Magia Naturalis,' and is conspicuous in the works of the system-mongers of the age, who replaced the old metaphysical constructions by others reared, though with imperfect knowledge, on a physical basis. Of these the most famous was BERNARDINO TELESIO (1508-1588) of Cosenza. This writer, who so influenced his time as to found a school, prefaced his work, 'De Natura Rerum' (1565-66), with a protest against the inadequacy of the Aristotelian physics,

[1] This is referred to in the chapter on Harmonics (De Aug.) in such a manner as to countenance the view of Mr Ellis that Bacon was acquainted with the works of Fludd.

[2] In his work 'De Subtilitate et Varietate Rerum.'

[3] Bacon certainly consulted Porta, and seems to have derived from the 'De Occultis Literarum Notis' (published 1563) hints for his scheme of ciphers.

giving an account of his rejection of them in almost Baconian terms. "Those before us seem to have prosecuted their examination of the world with great labour, but never to have looked at it, and so made an arbitrary world of their own. We, not relying on ourselves, and of a duller intellect than they, propose to turn our regards to the world itself and its parts. . . . The construction of the world and nature of bodies in it is to be investigated by the senses and not by reasoning." When, however, we come to examine his own system, we find the *à priori* method still substituted for the experimental, as with his predecessors.[1] His cosmogony, that of Parmenides and Democritus mixed, rests on the postulates of atomic matter as the substratum of body, and two incorporeal powers which contend for its mastery — Heat the source of motion, and Cold the principle of immobility; conceptions even more arbitrary than those he sought to replace. Bacon treats with indulgence a scheme which he to some extent followed; but he admits that Telesio was more successful in destroying than in building. The same criticism may be passed on PATRICIUS (1529-1597), who, after parading his "philosophy of the universe found anew," and the now trite denunciations of Aristotle, introduces his readers to smatterings of science, — speculations on the saltness of the sea, the tides, the sex of plants, &c.—bound or confused together by reference to the idea of "Light," which he

[1] Where, however, he follows Galen in holding that developed arterial and other organic systems have their original in germ, modern research supports him against Bacon's censure (Nov. Org., ii.) of having arrived at this conclusion "leviter et inscite."

employed to give to his assumptions the borrowed dignity of principles.

About the same time ANDREAS CESALPINUS of Arezzo (1519-1603), the first great modern botanist, in his 'Questiones Peripateticæ,' while giving suggestive hints as to the "three steps of knowledge, — Induction, from likeness and agreement, arriving at Universals; Division, from observation of dissimilarity discriminating species; and Definition, resolving its subject into elements"—shows himself in the main a disciple of Averroès.

A more attractive figure among the later Platonists, from his fame as one of the last martyrs of philosophy, and the imaginative style in which he clothed his conceptions, is GIORDANO BRUNO of Nola (1550-1600). His three main works are all in the lively, but, from the temptation it affords to aggressive wit, somewhat dangerous form of dialogue afterwards adopted by Galileo. Of these the 'La Cena delle Ceneri,' interesting as the record of a philosophic evening at the house of Sir Fulke Greville, during the author's visit to England (1583-84), professes to set forth a physical view of the world, in which (with a use of geometrical conceptions, recalling those of the Timæus), he extols Copernicus as a mathematician rather than a philosopher, insists with the tenacity of a Pythagorean on the necessity of circular motion, and derides the idea of the gravitation of bodies. In this dialogue one of the interlocutors observes, "In antiquity is wisdom;" the other answers, "No—we are older and have lived longer than our predecessors." During the following years Bruno formulated his metaphysics in his 'Della

Causa, Principio ed Uno,' and 'Dell' Infinito Universo e Mondi.' With less of Alchemy and more that is directly traceable to the Eleatics, Plotinus, and possibly oriental sources, these are to a large extent Paracelsian. The leading idea that the world and all it contains, plants as well as moving creatures, are inspired by an intelligent soul, the "anima mundi" seems definitely Pantheistic. Bruno's scheme is in essence rather derived than original; but it is animated by poetic expression, flashes of insight—as when he first asserts that the stars are suns with planets rolling round them,—and obscured by relics of medieval allegory, as the association of Form with the male, Matter with the female principle of the universe. Hallam's criticism of the more mystical part of his work is applicable to the whole school of those before and after him who confound clearness with superficiality and obscurity with depth. "The speculations of Bruno now become more and more subtle, and he admits that our understandings cannot grasp what he pretends to demonstrate—the identity of a simply active and simply passive principle; the question really is whether we can see any meaning in his propositions." The place of Bruno in the development of physical inquiry is of comparatively little moment; but in his recognition of the immanence of the divine in the universe, his assertion of the Deity as a power not external but internal through all its workings, of the essential unity binding together God, Nature, and Man, his philosophy is a link in the chain of modern Idealism.

Thomas Campanella (1568-1639) remains among the sixteenth-century Platonists to be ranked as a prede-

cessor of Bacon; for though he lived later, his main work, 'De Sensu Rerum,'[1] the record of a precocious genius, was published as early as 1590. In this he avows himself a follower of Telesio, and justifies his position by a general acceptance of his master's views, attaching, however, more weight to their moral aspect, and, in the manner of Bruno, to the principle of life pervading the universe. He begins, like Telesio, with a protest against authority, and gives a similar outline of his emancipation from its thralls; stating that, after a careful study of Aristotle, Plato, Galen, and the Stoics, and their commentators, he was driven "to compare them with that first and original writing the world," the "living statue of God," whose purposes he found directly chiselled in signs and types on all His works. All created things, he insists, are sensible, else the world would be a chaos; in this, again, recalling the mysticism which substitutes a transference of human emotion to the universe, for the slower discovery and calmer recognition of its laws. According to Campanella, space and matter are the warp and woof of the "all wise and good"; Heat and Cold His workmen: to these agents he also seems to assign some sort of consciousness, asserting that Heat has a desire for its own being, that feeling makes fire go up, and stones down, and that a love of like for like, opposed to the contrariety which is decay, leads waters in their course to the sea. Throughout his physics are confused, as

[1] Campanella's 'Civitas Solis,' written at a later date during the years of his imprisonment, may in some points be compared with the 'New Atlantis,' but the coincidences are probably accidental. The resemblances to passages in Plato's 'Republic' and More's 'Utopia' are more numerous.

those of the Greeks, by premature analogies; and his readiness to accept new views—*e.g.*, those of Gilbert—loses much of its value by his putting them to a vague use. He seems to have failed to realise the consequence of his own approved maxim, "Definition is the end and epilogue of science." A zealous advocate of the Copernican system, he surrounded it with the fanciful halos formerly attached to the old Astronomy. In his belief that the world is full of spirits, and, when the soul shall be delivered from this dark cavern, we shall behold their subtle essences, he shows himself a mystic of the modern school. In his assertion that the sky and stars signify thoughts to each other by their own lights, and that the blessed spirits informing those living mansions behold all things in the divine idea, he is, like Bruno, a poet more than a philosopher, and sets a text for the speech of Lorenzo in Portia's garden, or the reveries of Goethe's Faust, rather than for the almost equally sublime conclusions of Laplace.

Most of those pioneers of physical speculation were, in their lives, leaders of forlorn hopes, when Church and State, still apt to confound progress with rebellion, had replaced the old charge of magician by that of heresiarch. But it must be admitted that in many cases their own defects of temper and method were in part responsible for the antagonism they aroused. With few exceptions they were over-daring in their challenge to the past, and over-confident in themselves. Insufficiently versed in the sciences they studied, to recognise their bounds, they failed to see the limits of their power. Each of them, with few exceptions, inspired by an overweening ambition often arrogantly

expressed, writes as if he were starting afresh: each in turn assumes the tone, "They have said of old, but I tell you." Unaware of the almost infinite extent of the arena they professed to have explored, none of those speculators hesitated, any more than Bacon—in this respect their latest heir—hesitated, to pass judgment on everything. The self-assumption and imaginative vagaries of the Platonists had, with ecclesiastical and political conservatism, their share in promoting a reaction in favour of a more definite system. Scholasticism proper, dying hard, still found a refuge in the Catholic Universities which, mainly under the direction of the Franciscans, Dominicans, and Jesuits, still taught the old metaphysics. The counter-influence of the Academies,[1] now being established in Italy as centres for the cultivation of the modern languages, did not make itself widely felt till a somewhat later period, and the same may be said of the great Vatican, Laurentian, and other libraries. Wherever the Church had a mastering control, the bygone generations still governed from their graves: but the conclusions and methods of medievalism were nowhere allowed to pass unquestioned; the laity, no longer silent through ignorance, and only in some directions fettered by fear, had begun to speak their minds, and the more en-

[1] The chief of those were the Academies of Siena (1525), of Padua and of Modena (1534), of Florence (1540), and of Rome early in the century. The first distinctly devoted to "Nature" (if we except the special medical and botanical schools) seems to have been "The Academy of the Lincei at Florence, instituted for the study 'magni naturæ libri.'" M. de Rémusat has pointed out that Bacon's name is found on the list of rejected candidates for admission, but intimates that it may have been brought forward without his knowledge, and assigns the rejection to theological grounds.

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lightened among the clergy were preparing to accept the new conditions. Spain itself, the stronghold of ecclesiastical antiquarianism, had been brought, as the foster-mother of maritime discovery, into contact with a wider world; and, early in the century, one of the most direct assaults on the later schoolmen was delivered by the Ludovicus Vives of Valencia (1492-1540), whose work, 'De corruptis artibus et tradendis disciplinis,' in harmony with the spirit of the Renaissance, sets forth as its aim to remove impediments to the studies of 'Literæ Humaniores.'[1] The progress and growing love of art, the desire for greater grace and variety of life, was in the south of Europe tending to the same result as the insurrection in the north on behalf of greater purity and some amount of freedom in thought. The Reformation shook the power and narrowed the sway of the central authority over the intellectual as well as the spiritual world; it renewed the courage that had been temporarily inspired by the schism of the fourteenth century, confirmed the work of satirists such as Rabelais, and took advantage of the growing weakness fostered by dissensions of Dominican, Franciscan, Thomist, and Scotist, to set against the decrees of the Church a new alternative. But on abstract questions the Reformers were sharply divided. Luther, though the greatest the least widely read, arraigned the methods in the same terms of reckless vehemence with which he denounced the dogmas of the schools. Reuchlin was a Platonist, and Melanchthon at least ultimately an Aristotelian. The Protestants, moved, by their own

[1] It is curious to note that this direct forerunner of Ramus became the tutor of the Princess Mary of England.

counter-intolerance, to deny whatever the Catholic Universities affirmed, often assailed the old logic, physics, and ethics, on the same inadequate grounds on which they hesitated to accept the Gregorian Calendar. Even Science (to which till near the close of the century they contributed nothing) coming from a suspected source was suspect. "St Thomas," says M. Rémusat, "had to suffer for Rome, and Aristotle for St Thomas." During the period of fanaticism in England under Edward VI., the books of Duns Scotus were torn up, and their leaves scattered among the college quadrangles. But the new disputations were as tiresome as the old, and equally merit the oblivion they share.

The great protesting logician of the age, PETER RAMUS (1515-1572), owes his reputation to his death at "St Bartholomew," and the loud dogmatic assertion of his claims, rather than to any real originality. Coming into notice when, as a student at Paris in 1535, he took for his degree thesis the theme, "Not all that Aristotle has said is true," he, eight years later, as a professor in the University, promulgated a system evidently suggested by Plato's 'Sophist,' by which he designed to replace the 'Organon.' Ramus's own view of logic mainly differs from that of Aristotle by the extension of its province over that commonly assigned to rhetoric, in treating which he borrowed many of his often apt examples from Cicero and Quintilian. The first head of his work, "Invention, or the Art of Finding Arguments," is, however, based on the 'Topics'; and his division of propositions into those true universally, primarily, and essentially, corresponds to that of the principles of demonstration, *καθόλου*,

κατὰ παντός and καθ ἀυτό, in the Posterior Analytics (i. 4). These revived distinctions, to which, in his thirst for the show of novelty, Ramus gave the affected titles of the rules of wisdom, truth, and justice, Bacon extols;[1] but he protests against the Ramean dichotomy as "a cloud that obscured knowledge," and blew away after injuring the sciences. In this judgment most critics concur. Aristotle himself objects to bimembral division—*i.e.*, on the ground of the absence or presence of one quality—as leaving the negative side almost meaningless; and Professor Owen asserts that no advance in science was ever made by its employment. It pervades all the system of Ramus, detracts from the value of his classification, and prevents him from arriving at sound definitions. The second part of his treatise on Judgment and Disposition is ancient in all but phraseology (*e.g.*, the use of axioma, as enunciation, in the Baconian sense), and the fact that the third is exalted over the first "figure" as the normal type of syllogistic reasoning.

Ramus is more open than Aristotle to the charge of pedantically arguing from words to things, and turning physics into logic; but his vaunted reforms had considerable currency. Fifty years after the author had been driven from Paris for professing his views, the philosophical chairs in the universities were divided between Aristotelians and Ramists. Later still, Andrew Melville introduced the new system into Scotland, and Milton

[1] *Vide* 'De Augmentis,' vi. 2. Bacon has made use of two of these divisions in an obscure passage of the 'Valerius Terminus.' In the 'Temporis Partus Masculus' he speaks of Ramus with contempt, referring to him as "Aristotelis rebellis neotericus," "ignorantiæ latibulo," "compendiorum pater," &c.

made it the model of his treatise, 'Artis Logicæ plenior Institutio ad Petri Rami methodum concinnata.' Meanwhile Melanchthon had, with some modifications, partially reinstated the Peripatetic philosophy in the councils of the Reformers, and in the latter half of the century Aristotle, disentangled from scholasticism, re-emerged with much of his old authority. In the controversy thus more rationally renewed, men of equal culture could afford to take opposite sides.

Fabricius of Aquapendente (1537-1619), an anatomist of the Paduan school, and tutor of William Harvey, professed, in answer to Patricius, his appreciation of the elements of truth in the writers of antiquity, and of the acuteness, even where technically incorrect, of their physical conjectures; while Nizolius of Bersallo, a noted Ciceronian and keen Nominalist, recorded (1553), in his work on 'The Principles of the Arts and Sciences refuting the Falsehoods of the Metaphysicians,' his belief that error and barbarism would prevail as long as Aristotle ruled.

Similarly, the Portuguese physician Francisco Sanchez, in his work 'Quod nihil Scitur,' 1576, inspired by a mild Pyrrhonism, attacked the syllogistic logic as built on mere abstractions; and J. Aconcio, a Protestant Italian refugee, published at Basle, 1558, in his 'De Methodo,' a sketch of a new discipline of investigation, "Recta contemplandi docendique ratio," in which he insists on the need of new rules for Definition. To know anything, he contends, is to know its causes and effects: all men have within them the germs of knowledge: the task of logic is to blow to a flame the sparks lurking under the ashes. His analytic method has been

adjudged sounder than that of Ramus, but it was less trumpeted, and comparatively little known.[1]

There is a sense in which Aristotle has never been overthrown: the old 'Organon' keeps its place beside the new as a map of the processes of the mind: the 'Politics' and the 'Ethics,' which did so much to mould the thought of Hooker, and left their stamp on the 'De Augmentis,' share, and fortunately share, with 'The Republic' a commanding influence even over the speculations of the nineteenth century. The usurpation of Aristotle over a domain not his by right, a usurpation maintained by his followers rather than himself, was brought to a close, not by argument, but by the revelation of facts with which the old formulæ were manifestly inadequate to deal. The latter part of the sixteenth century was as rife in inventions as in change. History and Jurisprudence were having a new birth in the works of Machiavel, Guicciardini, and Bodin. The results of western and eastern voyages were being recorded in the maps of Ortelius and Mercator, and in the books of travel by Ramusio, Hakluyt, and Joseph d'Acosta, which brought their tributes of observation to the 'Globus Intellectualis.' The extension of Geography giving a stimulus to Geodosy, suggested Casmann's 'Problemata Marina,' the attempt of Chrysogonus to form a theory of "The Tides," and that of the physician Fernelius (1550-1558) to determine anew the magnitude of the earth. The progress of medicine in particular,

[1] Aconcio, Contio, or Aconzio, lived during a considerable part of his life in England; but Bacon does not appear to have heard of his work.

now comparatively free from the *ignis fatuus* of alchemy, and aided by the growth of institutions especially devoted to its service, anticipated the course prescribed by the Baconian philosophy. Fracastorius (1483-1553) had, before the middle of the century, made an alliance between his art and literature; later, VESALIUS (1514-1564), the first great dissector, was followed by Ambrose Paré, Eustachius, and Fallopius. In the kindred department of botany, Duval, Brunfels, Bock, Leonard Fuchs, and Luca Ghini (custodian at Pisa of the first Botanical garden) led up to Cesalpinus and Bauhin; while Conrad Gesner (1561-1565) laid the foundations of modern zoology. Mathematics were represented by Maurolycus, the first geometrician and optician of his age; and Vieta, successor of Cardan and predecessor of Harriot, the foremost algebraist. In physics, J. B. Benedetti was the earliest to recognise the tendency of propelled bodies to move in straight lines, and to analyse the composition of forces; while Simon Stevinus of Bruges, as early as 1585, by giving the first correct theory of the inclined plane, and of the vertical pressure of fluids, opened a new era in statics and hydrostatics.

But the most important discoveries of the age were made by a cluster of astronomers,[1] who, living almost in the same generation, seemed by destiny, if not design, to draw out each other's qualities and to supplement

[1] Of the romantic careers of those great men, who are, with Copernicus, the fathers of modern astronomy, it is only possible here to note that the fact of their all being more or less victims to the prejudices of their age is, in some measure, an excuse for the habitually cautious attitude maintained, despite his parade of defiance, by Francis Bacon, who had certainly no wish to be included with them in any future volume on "The Martyrs of Science."

each other's defects. The work of the first—the illustrious Dane, Tycho Brahe (1546-1601)—was to arrange and establish the foundations on which his successors built. The greatest of observers up to his time, or, without a telescope, of any age, he, by the aid of quadrants, sextants, and other instruments which would now seem comparatively rude, accumulated more new facts about the heavens than had been revealed since the date of Hipparchus. Of these we need only mention the first realisation of Seneca's forecast as to the possibility of predicting a comet's path, an estimate hardly now surpassed in accuracy of the irregularities of the lunar motion —*i.e.*, the equation of the centre and evection known to Ptolemy, the variation rediscovered after Aboul Wefa, the change of Inclination, and the inequality of the Nodes —with a minute record and analysis of the position of the planet Mars. Tycho could not theorise. He discovered the wards of the lock, but failed to find the key. His condemnation of Copernicus, who in his view "moved the earth from its foundations, stopped the revolution of the firmament, made the sun stand still, and subverted the whole ancient order of the universe," is more consistently maintained than Bacon's; and his own view, with some modifications, was similar to Bacon's. For, whereas the Pythagoreans made the earth revolve with the sun around a central fire, Tycho made the sun, with the other planets attendant, revolve round the earth.[1]

There has never been, in the history of science, so remarkable a conjunction of complementary genius as oc-

[1] Cf. Bacon: "I affirm the sun-following arrangement of Venus and Mercury, since it has been found by Galileo that Jupiter also has attendants."

curred when, in 1600, Tycho invited Kepler to join him in the work of his observatory at Prague. JOHN KEPLER (1571-1630), a born theorist and enthusiast, long immersed in the "somnia Pythagorea," the mystic mathematics of his 'Mysterium Cosmographicum' (1596), turned the imaginative power—as essential to the great discoverer as to the poet—to creative use when he came in contact with the man of facts. The first fruit of this happy association was the 'Rudolphine Tables' (so called from the Austrian Emperor, Tycho's host after his expulsion from Uraniberg), a new catalogue of the stars, which, though not published till many years after (1627), was constructed during the lifetime of the friends. On Tycho's death, Kepler set himself to reconcile the mass of observations left to his charge with the Copernican system. The result appeared in his work 'De Stellâ Martis' (pub. 1609), in which, after lingering fantasies about harmonies and a rhapsodical narration of his struggles with the planet, he sets forth his first two great Laws:[1]—

1. *The planets move round the sun, but in ellipses, not in circles; and the sun is in one of the foci of the ellipse.* 2. *The motion is not uniform; but the planet moves over equal areas, bounded by lines drawn to it from the sun, in equal times*—or, in technical terms, the "*radius vector sweeps over equal areas in equal times.*"

Nine years later, Kepler in his 'Harmonice Mundi,' dedicated 1618 to James I.,[2] gave to the world his third

[1] The proof at first only applied to "Mars," but Kepler soon extended it to the other planets.

[2] James, who thought the 'Organum' "past understanding," probably never looked at Kepler's work; but his first two Laws were familiar to Harriot in 1610.

Law. 3. *The squares of the periods of the revolution of the planets are to each other as the cubes of their mean distances from the sun.* In thus passing from a mere formularising of geometrical to the establishment of a physical relationship between the heavenly bodies, the author, conscious of the greatness of his discovery, breaks into a pæan that time has vindicated, and that suggests the almost contemporary self-acclamations of the 'Novum Organum':—

"It is now eighteen months since I got the first glimpse of light, three months since the dawn, very few days since the unveiled sun burst upon me. . . . I will indulge in my sacred fury. . . . I have stolen the golden vases of the Egyptians to build up a tabernacle for my God—far away from the confines of Egypt. If you forgive me, I rejoice; if you are angry, I can bear it: the die is cast, the book is written, to be read either now or by posterity—I care not which: it may well wait a century for a reader, as God has waited 6000 years for an observer."

That this knell of the old astronomy should not have been heard by Bacon is readily accounted for by the manner in which, at the time of its publication, he was engaged; but that he knew as little of Kepler's earlier work, and never names him, points to one of the strangest of his ignorances. Bacon's knowledge of foreign science seems to have come almost solely from Italy. There is ample evidence of his acquaintance with the work of the third and greatest of the group of his immediate precursors. Kepler's ultimate success has been justly appealed to as the most salient previous example of the utility of a part of the inductive process which Bacon unduly despised — the

application to an adequate number of facts of constructive hypotheses; and the *naïveté* of Kepler's narration of his own false as of his true conjectures, only adds force to the criticism. By fancy after fancy, guess on guess, he drove Nature to her hiding-place and won her secrets. No quotation or image has ever more adroitly represented her relation to the discoverer than his own from Virgil:—

> "Malo me Galatea petit, lasciva puella:
> Et fugit ad salices, et se cupit ante videri."

Kepler reproaches Bacon's timidity; Galileo, his overconfidence. The transcendent fame of the great Italian, like that of Leonardo da Vinci, rests on the versatility of his genius. But, with a mind almost as cosmic in its range as that of Bacon himself, he better understood the relations of a limited life to a limitless field; and set himself, in more strictly defined departments, to acquire and communicate more definite results. While the Englishman was boldly rearing a temple "full of long-sounding corridors," the Italian was supplying apparatus to fill it.

Galileo Galilei (1564-1642), when a youth at the University of Pisa, protested, in almost the same terms as Bacon a few years earlier, against the Aristotelianism of his age, and soon pushed his protests to still bolder conclusions. To the passage about studying Nature directly as the book of the universe (in a letter to Kepler, of date 1597), Galileo adds, "When we have her decrees, authority goes for nothing; reason is absolute." In the course of the same correspondence, writing from a mathematical chair at Padua, he confesses that

though he had for several years embraced the Copernican, he still taught the Ptolemaic system; and points out that neither is consistent with the views of Aristotle, nor with the Scriptures, which, he maintained, were not designed to teach philosophy. The last declaration led to his first citation to Rome, trial, censure, and promise of silence, the breach of which, in the famous dialogues on the System of the World, 1632, was the cause of his second arraignment, retractation, temporary imprisonment, and final retirement to the villa of Arcetri. Whatever doubt may exist as to the sincerity of Bacon's strongly professed orthodoxy, about the outward acquiescence of Galileo there is none. It was the mere enforced submission of a great man who had had enough of martyrdom to make him retire from the strife, with a stifled contempt for his persecutors, and the mental reserve typified, if not really expressed, in the traditional aside in the Inquisition chamber, "It moves, all the same." The caution which went along with his spirit of defiance is, in all his scientific work, of practical service. He flouted the men who would not look through his telescope,[1] and could not refrain from exasperating them with his wit; but the discoveries which ultimately transformed the physics of his age were made step by step, in a manner that has been called more Baconian than Bacon's. Hence their definiteness and their accuracy. Galileo's mistakes are insignificant; his achievements unassailable. His astronomical discoveries, made in rapid succession (1609-1611),—of the inequali-

[1] The idea of the telescope was suggested to Galileo by a report at Venice, 1609, of the invention of a Dutch optician, to whom he stands in somewhat the same relation as Guttenberg to Laurence Costar.

ties on the surface of the moon, and its diurnal libration; the round discs of the planets, of the satellites of Jupiter; the nature of some of the nebulæ; the ring of Saturn; the spots on the sun, and its revolution on its axis; and the phases of Venus,—were all important in themselves, and strong analogical arguments for the Copernican theory. His enunciation of the laws of falling and his treatise on floating bodies (1612) are distinct steps in dynamics and hydrostatics. His exactitude and sense of limitation is apparent in the anticipatory protest against Bacon's view of Induction—"It is impossible to give *all* the particulars where the cases are innumerable; where they are restricted, nothing new is added."

Meanwhile in England, the foundations of an almost wholly new science had been solidly laid by an experimentalist and thinker, to whom Galileo accords the praise of his generously expressed envy, as an author whose fresh first-hand views contrast with the mere repetitions of others who only "quote and quote to swell their books." William Gilbert, of Colchester (1540-1603), has been justly entitled the father of magnetism. "His work," says Whewell, "contains all the fundamental facts of the science so fully stated that we have at this day little to add to them." This writer is of almost as much interest to us from his anticipation of the comparatively impartial spirit of modern criticism, as from his positive achievements. In his two works, 'De Magnete' (1600) and the 'De Mundo Nostro,' published after his death in 1603, Gilbert, whose own researches are mainly concerned with a theme of which the ancients knew nothing, save a few isolated phe-

nomena, yet treats their leading thinkers with due respect, acknowledging that "from them the stream of wisdom has descended to posterity;" while he adds, "but our age has discovered and brought to light many things which they, if they were alive, would gladly embrace." Tracing the progress of thought from the simplicity and ignorance of the early speculators to Aristotle and Galen, he expresses his disapproval of the host of commentators who perverted their masters' teaching, laments "the shipwreck of science in the deluge of Goths," and rejoices at "its revival in the time of our grandfathers." The later age, he says, "has exploded the barbarians and restored the Greeks and Latins to their pristine honour." If these, too, are responsible for errors that still mislead us, the remedy is to be found in science again taking its start from observation and experiment, in attending to the productive processes, "frugifera instituta," of Nature herself. The results of his own inductions[1] pursued on this principle are, as far as they go, remarkably correct. He not only laid down the main facts of magnetism—*e.g.*, clearly recognising its polarity—but had obviously grasped the parallel between it and electricity; and in his assertion that the earth itself is subject to the same laws as the artificial magnet, his "Terella," he had

[1] There can be little doubt that Gilbert was a Copernican. Sometimes he speaks as if any other view were absurd. Dr Whewell asserts that, maintaining the diurnal, he hesitated about the annual, rotation of the earth; but Mr Hallam points out that his argument for the one extends to the other. "Cum natura semper agit per pauciora magis quam plura; atque rationi magis consentaneum videtur unum exiguum corpus telluris diurnam volutationem efficere quam mundum totum circumferri."

caught hold of the idea of force acting at a distance, of no less value because it was still impossible for him clearly to distinguish magnetism and gravity.

Bacon is nowhere more open to the charge of Ottoman fratricide than when he censures a man who had so exactly anticipated much of what is most cogent in his own views, as a mere specialist so consumed by one-sided zeal as to believe himself a magnet. Nowhere does he show more obtuseness than in his refusal to recognise the importance of the principle of attraction and repulsion, which he confounds with his own *à priori* conception of "conforming natures." But elsewhere he accords to Gilbert a more due meed, and the prominence he gives to his name testifies to a sense of his importance.

Of other eminent Englishmen of the time who helped to lay the rafters of the bridge from the old world of speculation to the new world of discovery we need here only name—Thomas Harriot (1560-1621), the mathematician, famous for his solution of cubic equations, and co-discoverer with Galileo of the solar spots and Jupiter's satellites; John Napier (1550-1617), whose logarithmic tables (1594-1614), according to Laplace, "doubled the life of astronomers by reducing the labour of months to days;" and William Harvey, who, in 1619, announcing his discovery of the circulation of the blood, opened a new era of physiology.

These were the κήρυκες Διός ἄγγελοι ἠδὲ καὶ ἀνδρῶν who gave to Bacon his materials, and helped to form his mind. He owed as much to the spirit of an age of Protestantism, in a wider than the theologic sense, of expanded experience in all directions, of the full influ-

ence of the press, the breaking up of the old ecclesiastical unity; of the growing beliefs in the importance of secular knowledge, in progress as an essential of human life, and in the largeness and richness of nature. "There needed," says Dr Whewell, "some great theoretical reformer to speak in the name of the experimental philosophy, and to lay before the world a declaration of its rights."

II.—THE 'INSTAURATIO MAGNA.'

CHAPTER I.

THE DESIGN, PLAN, AND PROGRESS OF BACON'S WORK.

Homer, it has been said, was an exaltation of the Cyclic romancers. Dante gathered to a centre all the poetry latent in the early ages of the Church: Chaucer, by his own confession, fed on the fields of the Trouvères; Shakespeare glorified the previous traditions of the English Drama. But our interest in their ancestors is mainly due to what these men have done. Similarly, if in a less degree, Bacon has sent his readers to search the past, with which half his writing is engaged. He must have been aware that he had been to a great extent forestalled by his predecessors; that he formulised rather than invented, condensed rather than devised, the assault on the methods of the Scholasticism which, in his day, haunted men's minds only in the guise of an unlaid ghost: but he was probably unconscious of the extent of his debts, and the disingenuousness with which he

strove to minimise them is frequent in ages of revolt. With him and with Descartes[1] Modern Philosophy begins, under forms so different that the application to their work of the same name has been questioned; but between the two writers there is, in several respects, an affinity. Both felt the need of a reform, and had an overweening assurance of having accomplished it. Descartes says, "I do not recommend the study of my method as an aid to the study of mathematics, but the study of mathematics as an illustration of my method;" and Bacon declares, "I believe that I have, for ever and legitimately, united the empirical method and the rational method, the divorce of which is fatal to science and to humanity." Both were laymen—the one a lawyer, bent on natural philosophy, the other a soldier and geometrician—inspired with a contempt for authority in the domain of thought. "The most general feature," says M. Cousin, "of the philosophical revolution of the sixteenth and seventeenth centuries is independence, both of ecclesiasticism and the admiration of ancient genius. Comparative disdain and ignorance of the greatest thinkers of Greece were the ransom of its independence. Leibnitz excepted, none of the leading philosophers of the new era had much real knowledge of antiquity. Descartes, Hobbes, Spinoza, and Locke hardly read anything else than is found in nature and in consciousness." Bacon, though more learned than those writers, was the protagonist of their revolutionary spirit. That which

[1] Born 1596, Descartes was a generation younger than Bacon; but the dates of the publication of the 'Novum Organum' (1620) and of the 'Discourse on Method' (1637) may be compared as indicating the starting-points of their philosophic influence.

had turned away from the phenomenal world was dead: men were reawakened to the diversity of life: it was time for their minds to assume confidence, and force their way through new labyrinths. This confidence Bacon's work was, more than that of his forerunners, by the larger utterance it gave to a more fully rounded design, fitted to instil. He had been anticipated in fragments, which he first brought together in a connected and apparently conclusive form. After the suns and showers of three centuries had been ripening the grain, he announced the harvest.

In dealing with his philosophy, we shall first endeavour to state his central idea, then to illustrate its development, finally to exhibit the causes of his failure—for he did fail in what he cared for most, and his permanent achievements have been collateral. Bacon has been accepted as an unreliable though often incisive critic, a frequently inaccurate though zealous observer, and a one-sided though suggestive logician. His own idea of his position was that of a discoverer of a "mundus alter et idem," a new world, of more moment to mankind than the Indies of Columbus. He would have received with indignation the verdict that his work was mainly negative; that he would be known to the future by his incidental wisdom, his warnings against the "ignes fatui" of the schools, or the errors, "more to be feared than they," which are "always with us"; that he would be commended by popular rhetoricians for his practical aims, or that, *mutatis mutandis*, his verdict on the alchemists would be pronounced on himself. He arraigned the thinkers of the past because he fancied himself to have found what they had missed; he assailed

their love of system because he had a supplanting system; he despised their *à priori* imaginations because, by the excuse of an imagination almost Shakespearian in its daring in another field, he conceived himself to have banished from the future of the physical drama the need for further imaginings. Nowhere do we find a more exalted conception of the majesty of Nature than in Bacon's work; but he holds it as a cardinal doctrine that she is finite, that the time is at hand when all essential knowledge may be grasped, the world well won, and the age of the Garden before the Fall restored. Bacon constantly insists that we must enter the kingdom of Nature "sub personâ infantis," but he has himself the air of one taking possession of a throne. He had little of the submissive or reverential spirit which led Newton, amid the acclaim of his great discovery, to confess himself still "a child gathering pebbles on the shore of the infinite sea," or that of the modern poet "moving about in worlds not realised." His always proud humility lay in his acceptance of the dictum of the "Parmenides," that the least of Nature's manifestations is worthy of our note, that "he who feels contempt for any living thing hath faculties which he has never used;" but his aspirations as a thinker dwarfed his ambition as a statesman. By every image at command of a fancy among the masters of prose equalled by Plato alone, he impresses us with his belief in his possession of a clue, a key, a secret, that had come to him by a sort of inspiration. He had threaded the recesses of a labyrinth unknown to Theseus, unlocked the door barred alike to Aristotle and Aquinas, learned the "open sesame" where Paracelsus had been calling "wheat" and "rye." He had grazed the

beach of the 'New Atlantis,' though he might only live to blow the clarion for the colonising generations; he had realised the magic of which the *mayi* only dreamt. The gods had answered his prayer, as that of Pygmalion; for he knew the tune of "The Winter's Tale," to call the marble statues of the old philosophy down from their pedestals to take life and colour, and move, fostering, gladdening, and restoring, among men.

Bacon's idea of the 'Interpretation of Nature' receives some light from the crude pre-Socratic speculations on the one side, and on the other from the more defined though still unproved conjectures, as those of Boscowitch, on the border land where physics seem to merge into metaphysic. Like the earliest recorded thinkers of Greece, Bacon found his unity in an examination of the external world rather than in a mental analysis. He will accept none of their conclusions, and is alive to the inadequacy of the generalisations by which they were reached; but he holds that—in looking behind appearances to some physical bases, into which the shows of the universe may be resolved—they were on a path more fruitful of discovery than the impossible attempt to separate non-existent substances from attributes, or ideal paradigms from real things. His alienation from purely metaphysical modes of thought is conspicuous in all his criticisms. He replaces the opposition of phenomena and noumena by his analogies, sometimes fanciful, always suggestive, between all the spheres in which life and order are manifest. He is ready as any Greek or German to admit that "things are not what they seem;" but, setting aside the inscrutable truths of religion, he has no faith in anything that is not physical. His

"noumena" *are* "phenomena" interrogated and explained; Proteus grappled with through every *alias* till he returns to his proper shape; Heat confessing itself to be an expansive motion. In dealing, as in the 'De Principiis,' with the question of the ultimate nature of things, Bacon suggests rather than dogmatises; hazarding the view that all the assumed elements may be reduced to one, as has been imagined by chemists like Samuel Brown, who have tried to establish what the alchemists vaguely guessed. Bacon is nowhere bold enough to assert with Pythagoras, that all apparent varieties of quality are resolvable into arrangements of form,[1]—a view which is at the root of the doctrine that the difference, which is life, depends on number as the expression of geometry: but he feels confident in having gone far towards unity in his simplification of apparently complex natures. Nature, with him, is a mighty conjuress, who plays a myriad tricks with a few cards: man as "*interpres*" has to detect and as "minister" to re-play those tricks, and so by mocking to become her master. When we consider how many combinations may result from the various arrangement of, say, six solid factors, how many more if these factors are fluid, there appears nothing strange in the belief that everything that strikes any of our senses may be resolved into the action and reaction of a limited number of "simple"—*i.e.*, irresolvable—"natures." To discover these, by a process analogous to that of referring the conclusion of a syllogism to its premisses, is Bacon's

[1] If for the Pythagorean triangles, expressed by the disposition of their points, we substitute centres of living force, we have the monadism of Leibnitz.

prime quest; for as, in formal reasoning, the conclusion follows from the premisses, so, if we have once caught hold of the "motifs" or ἀρχαί of Nature, we shall be able to reproduce her results. The "unseen universe," by which we are surrounded, is thus at once the "garment of God" and the heritage of man.

Bacon dismisses as a superstition the idea that we profane the sanctuary in attempting to unravel its mysteries: the forbidden fruit is the reserve of the right of revelation to dictate to morality; the rest of the garden is the fulness of the primal life, to which we not only may but can return. Man is with him "the roof and crown of things," and his view of the relation of the chief of creatures to the rest of creation is perfectly expressed in the verse of his friend and coadjutor in translation, George Herbert:—

> "For us the winds do blow,
> The earth doth rest, heaven move, and fountains flow.
> . . . . . .
> Man is one world, and hath
> Another to attend him."

How Bacon proposed to attain the key to a kingdom richer than Raleigh's Eldorado, and what rendered his attempt in the main issue a futility, are questions the answer to which involves a history and criticism of his whole method and aim.

Of no philosophical writer is it more difficult to give an account, at once clear and sufficient. This arises first from the fact that his work is exceptionally incomplete. Of the three main contributions to his design, the 'De Augmentis' alone is finished. The fragment of the 'Novum Organum' is a head with-

out limbs, and the 'Sylva Sylvarum' a mass of disjointed though interesting observations. A volume remains of posthumously published discourses and discussions, for the most part forecasts of the 'Organum,' whose precise place in the author's scheme is often hard to determine. The second obstacle to a satisfactory analysis is Bacon's habit of repeating himself—the same idea being hunted, with the same phrases, over many fields—and the want of boundary-lines in his treatment of subjects so various. His cross-divisions are interminable; and with outlines of existing systems he mixes up rough anticipations rather than exact statements of his own. The 'Valerius Terminus' and 'The Advancement of Learning' already glance at his doctrine of Forms; his ethical and religious meditations are huddled rather than arranged in the later books of the 'De Augmentis'; and much of his earlier teaching is thrice told in the unmethodical aphorisms of his latest. One cannot ignore the minor treatises, because of the light they often throw on the major; but their biographical interest is diminished by uncertainty as to their dates, often marked by such slight indications as the discovery of a star, a reference to or fro, a change of opinion, a quotation, a greater or less maturity of view. The initial steps of his intellectual career are the more worthy of note, that no proximately complete collection[1]

[1] The only important contributions to the 'Instauratio Magna,' *published* by Bacon himself, were the 'Advancement of Learning,' the 'Novum Organum,' and the 'De Augmentis,' though he widely circulated the 'Cogitata et Visa,' and other tracts. The 'Sylva Sylvarum' was edited and published by Rawley in 1627—*i.e.*, the year after his master's death—as also the 'New Atlantis.' Rawley's further collection, the 'Resuscitatio of Sleeping Pieces,' ap-

of his writings was made till more than a century after his death, and that so much of his tentative work illustrates his ultimate design.

The first indication of his arraignment of the methods of teaching in his time is the reference of his biographer, Rawley, to the fact that when at Cambridge, as a boy of sixteen, he "fell into dislike of the philosophy of Aristotle, as only strong for disputations and contentions, but barren of works for the benefit of the life of man." The second is the 'Temporis Partus Maximus' (*vide ante*). The third is the remarkable letter sent in 1592 to Burghley, in chagrin at the failure of early suits for promotion, in which occur the characteristic and oft-repeated phrases—

"I wax now somewhat ancient; one-and-thirty years is a great deal of sand in the hour-glass. . . . I ever bare a mind to serve her Majesty, not as a man born under Sol, that loveth honour, nor under Jupiter, that loveth business (for the contemplative planet carrieth me away wholly), but as a man born under an excellent Sovereign that deserveth the dedication of all men's abilities. . . . I have as vast contemplative ends as I have moderate civil ends, for I have taken all knowledge to be my province; and if I could purge it of two sorts of rovers, whereof the one with frivolous disputations, confutations, and verbosities, the other with blind experiments and auricular traditions and

peared in 1657. Four years earlier, Grüter's contribution of letters and papers supplied to him by Sir William Boswell, ambassador to Amsterdam, had appeared under the title 'Impetus Philosophici.' Another collection was made by Tenison in 1679: that of Stephens was published in 1734. The complete—or professedly complete—editions of Bacon are those of Blackbourne, 1730; Mallet, 1740; Birch, 1763; Basil Montague, 1825-34; Spedding and Ellis, 1857-83. M. Bouillet has also issued in French an edition of the 'Œuvres Philosophiques,' Paris, 1834.

impostures, hath committed so many spoils, I hope I should bring in industrious observations and profitable inventions and discoveries—the best state of that province. This, whether it be curiosity, or vainglory, or nature, or (if one take it favourably) *philanthropia*, is so fixed in my mind as it cannot be removed." Then follows, almost menacingly, the resolve—"If your Lordships will not carry me on, I will not do as Anaxagoras did, who reduced himself to voluntary poverty; but this I will do: I will sell the inheritance that I have, and purchase some lease of quick revenue, or some office of gain that shall be executed by deputy, and so give over all care of service, and become some sorry book-maker, or a true pioneer in that mine of truth which (he said) lay so deep."

In a later address to the "Atlas of this Commonwealth," 1595, Bacon, referring to himself as "a tired sea-sick suitor," says: "I do not think the ordinary practice of the law, not serving the Queen in place, will be admitted for a good account of the poor talent which God has given me." In the same year he writes similarly to Essex (to whom he had previously spoken of retiring with a couple of men to Cambridge, there to spend his life in studies and contemplations), and adds: "I partly lean to Thales' opinion, that a philosopher may be rich if he will." The last of these philosophic resignations occurs in a letter to his cousin, after the accession of James, in which the writer professes that his ambition is now only in his pen, whereby he hopes to maintain his memory.

Bacon's appeals had no effect on the statesmen to whom they were mainly addressed. That Essex, indeed, recognised the promise of his *protégé* is seen otherwise than in his munificent gift; but the Cecils were deaf

alike to the cajolements and the threats of their kinsman: they probably regarded his high-sounding phrases as the rhetoric of a dreamer, and cared no more for the reform of reasoning than either of the sovereigns whom they served. Elizabeth, who preferred the witticisms of Andrew Borde to the 'Faery Queen,' knew of no sciences but those of statecraft and compliment; while James would have set more store by a refutation of Reginald Scot's 'Discovery of Witchcraft' than by the 'Novum Organum.' These early remonstrances are of value as revelations of the writer, and of the ideas and designs already "so fixed in his mind," that they could not be diverted from their centre by all the struggles and vicissitudes of forty years. Nowhere is the self-deception which Bacon carried with him through life more clearly marked than in his alternate tone of complaisance and confidence, his professed abandonment of ambitions by which he was perpetually, and to some extent fatally, swayed; the mixture of mean and magnanimous motives; his blending of personal with public ends. But we have here more especially to note his sense of the inadequacy of what had been done, of the almost limitless range of what might be done; conceptions (more distinctly announced than by any of his predecessors) of philosophy as at once the highest exercise of the mind, and, if need be, a gainful art. Amid the variety of Bacon's themes, there is a sameness, almost tiresome, in his style, which makes it easy to detect. On this ground alone there need be no hesitation in accepting Mr Spedding's view that the 'Letters of Advice' to the Earl of Rutland, and to Foulke Greville (1596) on Travel and Studies, attributed to the Earl of Essex, are really from

the hand of his friend. About the same time must have been written the Letter to Henry Saville,[1] as provost of Eton, "Touching Helps for the Intellectual Powers." This paper is a mere fragment, but such as might have been naturally addressed to a new head-master—giving hints for education, and rules for the cultivation of the memory.

Among the fragments belonging to this period, justly attributed to Bacon's authorship, are his contributions to the pedantic performances of the time, called "Devices," in which facts or fancies were set forth by imaginary characters, after the manner of the dreary Moralities then giving place to the real Drama—contributions rising above the commonplaces by which they were surrounded, almost as Comus transcends all other masques in verse. Of the two earliest, belonging to "a Triumph" given by Essex before the Court in 1592, the "Discourse in Praise of the Queen," amid much fulsome adulation, is marked by some of the writer's noblest patriotic sentiment; while the "Praise of Knowledge" is in his characteristic vein: *e.g.*—

"Are not the pleasures of the affections greater than the pleasures of the senses? And are not the pleasures of the intellect greater than the pleasures of the affections? Is not knowledge a truly and only natural pleasure, whereof there is no satiety? Is it not knowledge alone that doth clear the mind of all perturbations? . . . But is this a vein only of delight, and not of discovery—of contentment, and not of benefit? . . . Are we the richer by one poor invention, by

[1] *Vide* Spedding, vol. ii. pp. 9, 11, 12, 14, 22, and 25. Passages anticipate almost verbally the Essay on Studies. Cf. also the warning to Greville against Epitomes, and the praises of Tacitus and Thucydides, with the 'Advancement of Learning.'

reason of all the learning that hath been these many hundred years? The philosophy of the Grecians . . . is gathered out of a few vulgar observations; that of the alchemists out of a few experiments of a furnace. The one never faileth to multiply words, the other ever faileth to multiply gold. . . Let me so give every man his due, as I give Time his due, which is to discover truth. Many of these men had greater wits far above mine own, and so are many in the universities of Europe at this day. But, alas! they learn nothing there but to believe: first, to believe that others know that which they know not; and after, that themselves know that which they know not."

There is as little doubt as to Bacon's part in the speeches of the six counsellors in the Revels, "Gesta Grayorum," celebrated at his Inn of Court in January 1595. The first and fifth are certainly his own, the latter dwelling on the paramount importance of education as the guardian of the laws; the former, anticipating alike the suggestions of the 'Commentarius Solutus' and the imaginary realisation of 'Solomon's House.' The speeches of the Hermit and the Squire in the second, otherwise fantastic, "Device" of Essex, at the close of the year, are clearly from the same source. In January 1596 appeared the 'Promus of Formularies and Elegancies,' which (begun December 1594) first displayed the author's excess of quotation and aphorism, as did the 'Colours of Good and Evil' (appended with the 'Meditationes Sacræ,' to the first edition of the 'Essays') his love of antithesis. It has been conjectured that several philosophical "opuscula," afterwards superseded, may have been sketched during the later years of the century; but nothing of consequence was written, in this sphere, previous to Elizabeth's death. Early

in the new reign, the hitherto baffled statesman and discontented lawyer began to entertain the idea of popularising his researches into Nature, and planting the seed of his thought in such a manner that it "should have the best chance of growing, and in due season bearing its fruit." With this in view, he seems to have composed in Latin the "Proem" of his purposes, from which (in Spedding's translation) we extract:—

"Believing that I was born for the service of mankind, . . . I set myself to consider what service I was myself best fitted by nature to perform. Now, . . . if a man should succeed, not in striking out some new invention, . . . but in kindling a light in nature—a light that should at its very rising touch and illuminate all the border regions that confine upon the circle of our present knowledge; and so spreading further and further, *should presently disclose and bring into sight all that is most hidden and secret in the world*,[1]—that man (I thought) would be the benefactor indeed of the human race, the propagator of man's empire over the universe, the champion of liberty, the conqueror and subduer of necessities. For myself, I found that I was fitted for nothing so well as for the study of truth; as having a mind nimble and versatile enough to catch the resemblances of things (which is the chief point), and at the same time steady enough to fix and distinguish their subtler differences; as being gifted by nature with desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to reconsider, carefulness to dispose and set in order; and as being a man that neither affects what is new nor admires what is old, and hates every kind of imposture. So I thought my nature had a kind of familiarity and relationship with truth."

Bacon proceeds, with the complacency which alone

[1] It is worth note, that whereas in the letter to Burghley Bacon dwells on the discovery of new distinct arts, he here first seems to entertain the notion of one master-key to the secrets of nature.

detracts from the dignity of the piece, to attribute his desire to rise in the State solely to his wish to have a wider command of industry to aid his work; and then informs us that he felt himself no longer free to leave undone what he could do by himself. There follows one of the most striking and definite of political prophecies, afterwards repeated with a yet more precise reference to dangers brewing in the north, in the letter of advice to Villiers:—

"Nor am I discouraged from this work because I see signs in the times of the decline and overthrow of that knowledge and erudition which is now in use. Not that I apprehend any more barbarian invasions. . . . But the civil wars which may be expected, I think (judging from certain fashions which have come in of late), to spread through many countries, seem to portend for literature and the sciences a tempest no less fatal, and one against which the printing-office will be no effectual security. "Fair-weather learning," he concludes, "will sink under these impediments; but that maintained by 'works of utility and power will withstand them.' For himself, it is 'enough to have constructed the machine,' though he may not succeed in setting it on work. 'The lame man keeping the course won the race of the swift man who left it.' His heart is not set upon external things,—fame, or the founding of sects, or private gain,—to look for which in such an enterprise were 'both ridiculous and base.' Enough for him the consciousness of desert, and 'those results with which Fortune cannot interfere.'"

Bacon greatly overrated his power of discerning differences, and his profession of withdrawing from politics was probably as sincere as Cæsar's or Richard's refusal of the crown. Contemporaneously with the "Proem," he was writing his "Discourse on the Union

of the Kingdoms," in which solid arguments for the great measure he all but carried, appear side by side with an embryo treatise on Fluids, an expressed respect for the Persian magic, and an assertion that the mid-summer heat is due to the conjunction of certain stars. Nor far removed in time is the essay on "The Pacification of the Church," and the "Apology concerning the Earl of Essex." But the interval before his elevation to the Solicitorship was to him a time of comparative leisure from affairs, and the use he made of it is apparent in the fact that, during this period, he published (1605) the most popular of his philosophical works—'The Advancement of Learning'—and made other contributions towards the furtherance of his scheme.

To nearly the same date we must assign the 'Cogitationes de Rerum Naturâ,'[1] a series of jottings on natural history, in which are included the earliest that have come to us of the author's notes on Motion, and the 'Cogitationes de Scientiâ Humanâ'—three fragments setting forth the limits, end, and use of knowledge, illustrated by interpretations of fable, and of interest as containing several of the recurring maxims of the 'Organum,' and an anticipation of the 'Parasceve.' "Fundimenta solida Philosophiæ Naturalis in Naturali Historia jaciuntur."

The Valerius Terminus, or "Of the Interpretation of Nature," first distinctly (1603 ?) announcing a new

[1] This is an example of a work whose date is determined by conjecture. It has been concluded that, because Bacon refers to the new star in Cassiopeia, while he takes no notice of that in Ophiuchus, on which Galileo lectured in 1604, it must have been composed not long after that year.

philosophy, which is to put an end (Terminus) "to the wandering of mankind in search of truth," seems to have been designed to introduce the 'Instauratio,'—an expression, however, which Bacon began to use only in 1607. In this interesting fragment we have the four Idola of the 'Organum' with the same names, save that the term "of the palace" takes the place of "fori"; and, used in the same way, the expressions "axiom," "summary law," "simple nature," &c.; while the process of arriving at "Forms" is conveyed in the phrase "freeing of a direction."[1] This paper, especially in its application of the Ramean rules (*vide ante*), is beset by scholastic subtleties, and there is reason to believe that its obscurity was to some extent designed. Despite the author's desire that his discovery should be the world's gain, he had inherited, from the ages when it was the fashion (*vide ante*) to regard recently acquired knowledge[2]

[1] This practically means that when the false lights are extinguished and the wrong ways fenced off, the mind is more free to follow the true light, and walk in the straight way.

[2] In the dark and middle ages no new discovery was freely published, and the arts were carefully guarded mysteries. To be wiser than the time was a possible fortune or a danger: the fear of heresy combined with the pride of exclusiveness to make men cautious in the "traditio lampadis." The masters in alchemy handed down their secrets "ad filios." Roger Bacon is said to have recorded his invention of gunpowder, as Galileo his discovery of the phases of Venus, in an anagram. Harvey protests, "So new are my discoveries, that I dread the enmity of all." Bacon, while throwing down a reckless gauntlet to the past, is generally shy of giving offence to his contemporaries. In the 'Temporis Partus Masculus' he adopts a method such "ut idoneum et legitimum sibi lectorem seponet et quasi adoptet." In the 'Advancement of Learning' he advises "the entry of truth, with chalk to mark those minds which are capable to lodge and harbour it." The same view appears in his interpretation of the myths and the special preface to the 'Novum Organum.'

as a secret, the notion that there are truths best shown, at first, through a veil; that, in philosophy as in politics, "the vulgar" were to be treated as children; that there was a call for esoteric as well as exoteric teaching. His addition to the title of this work, "with the annotations of Hermes Stella," indicates that the starlight thrown on Nature's arcana would suffice to reveal them to the audience, "fit though few," it was intended to address. In chap. xviii. he defends the discretion of withholding part of the truth, and of "publishing in a manner not to the capacity of all, . . . both for the avoiding of abuse in the excluded and the strengthening of affection in the admitted." In numerous passages of the 'Redargutio' and the 'De Augmentis' we have similar traces of the reserve, belonging to a time when thought was fettered, surviving in the man who most emphatically pronounced it to be free. The popular side and the exclusive side of Bacon's nature; the arrogance of "procul este profani," and the conciliation of the prayer of the Miller of Huntingdon for "peace among his willows, that his water might have more work;" his inheritance and his anticipation; his latent scorn and his longing for aid,—are at war in his philosophy, as in his life. Sometimes the one mood, sometimes the other, is uppermost, and he allows himself to be swayed by the one or the other to suit the often inconsistent experiments of his plan. His anxiety to bring his thoughts before the world in such a form that they would be accepted, made him put on masks and seek shifts of secrecy, audacity, modesty, to gain a hearing. The same purpose accounts for the number of his tentative efforts, some of which, thrown aside, are

better than the corresponding portions of those finally adopted.

The date of the COGITATA ET VISA[1] is nearly fixed by the copy forwarded in 1607 to Sir Thomas Bodley. Another was, some time after, presented to Launcelot Andrews, Bishop of Ely, with a letter throwing light on the author's manner of composing his work :—

"I hasten not to publish ; perishing, I would prevent, . . . for with me it is thus : if I bind myself to an argument, it loadeth my mind ; but if I rid my mind of the present cogitation, it is rather a recreation. These miscellanies I purpose to suppress if God give me leave to write a just and perfect volume of philosophy, which I go on with slowly."

About the same time, to his friend Toby Matthews, with a copy of the 'De Sapientia Veterum,' he writes :—

"My great work goeth forward ; but, after my manner, I alter ever when I add. So that nothing is finished till all be finished."

And to Casaubon—

"You are right in supposing that my great desire is to draw the sciences out of their hiding-places into the light. How great an enterprise in this kind I am attempting, and with what small helps, you will learn perhaps hereafter."

The 'Cogitata et Visa,' covering the ground of the first book of the 'Organum,' begins by reference to the

[1] This is an expansion of a previous tract, "Filum Labyrinthi sive formula Inquisitionis," the *first* of three papers with the same title. The *second* is the "Inquisitio legitima de motu," mentioned (1608) in the 'Commentarius.' The *third* is the "Scala Intellectus," forming the preface to Part IV. of the 'Instauratio.' The same perplexing confusion of nomenclature appears in the two collections entitled 'Phenomena Universi.'

failure of the previous alchemy, magic, mechanics, and medicine, as relying rather on chance than philosophy. It was probably circulated after Bacon's appointment to the Solicitorship, and is distinguished from the 'Redargutio' by its calmer style of criticism. Already, in a preface to the 'Temporis Partus Masculus,' he had proposed to deal with the interpretation of nature in three books: 1. The Preparation, 'Perpolitio et Applicatio,' of the Mind = 'Novum Organum,' Book I.; 2. 'Lumen Naturæ, sive Formula Interpretationis' = 'Novum Organum,' Book II.; 3. 'Natura Illuminata, sive Veritas Rerum' = the unaccomplished conclusion of the 'Instauratio.'

In the 'Partis Instaurationis Secundæ Delineatio et Argumentum' (1606-1607), the initial survey of the sciences is presumed; the third, fourth, and sixth books are to deal with results, and the fifth is referred to as tentative. Bacon then lays down heads of the second, which is the training of the intellect in the art of interpretation. He lets this be called Logic, that he may lead men, as by the hand, with familiar names; but it differs from that commonly so called in the starting-point of its inquiry, the order of its demonstrations, and its end, which begins deeper and goes further. The end of the new science being "Res et Opera," to discover facts and perform works, we must be prepared to receive all the light that can be thrown on them, and to this three processes are essential: 1. *Mentis area æquanda*, the arena of the mind must be levelled by clearing away of misconceptions. There follows a reference to the "idola adscitia," with special emphasis laid on those arising from false philosophies. "Itaque

primus imponitur labor, ut omnis ista militia Theoriarum, quæ tantas dedit pugnas, mittatur ac relegetur." 2. *Conversio mentis bona—i.e.*, the mind must be made to face the new truths, and, freed from the "idola innata"; it must understand how great is the difference between these and the ideas of the divine mind—*i.e.*, the laws of the universe; above all, it must not despair of investigation as endless. "Ostendemus eam (*i.e.*, scientiarum regenerationem) errorum et vastitatis *terminum*." This part of the paper shows how definitely Bacon had already conceived the scheme of the 'Organum.' 3. The part which follows on the ministrations or aids to the Senses, the Memory, and the Reason, suggests some of the further developments which that work might have received had it advanced nearly to completion.

In 1609 appeared the 'De Sapientia Veterum,' remarkable as the only book (if we except the second edition of the Essays, 1612) that Bacon published between the 'Advancement of Learning' and the 'Novum Organum.' To the same interval belong several physical treatises, mostly fragmentary, among which the second "Filum Labyrinthi," with the short tracts on "Heat and Cold," "Sound and Hearing" (following a programme sketched in the 'Commentarius'), must have a date assigned to them after 1608. The first shows that the writer was already possessed by the idea that all the apparently diverse changes of nature were modes of motion,—an idea developed in the treatment of heat in the 'Novum Organum'; while the discussion of sound is expanded in the 'Sylva Sylvarum.' In the last-named collection are reproduced most of the facts and observations recorded in the first "Phenomena Universi sive

Historia Naturalis ad condendam Philosophiam"—designed to be an enumeration of the "cardinal virtues"—*i.e.*, the essential qualities in nature—and probably to introduce the third part of the 'Instauratio.' This was finally superseded by the later work of the same title in 1622; between which date and 1608 (when it is not mentioned in the 'Commentarius') it necessarily falls.

The date 1612 may be confidently assigned to the 'Descriptio Globi Intellectualis' and the 'Thema Cœli,' not only from their acceptance of the discoveries announced by Galileo in his 'Sidereus Nuncius' (1811), but by the reference to the star in Cygnus, first observed in 1600, as known for twelve years. The former is difficult to classify: the first three chapters are given to a division and survey of the sciences, while the rest of the book is a review of the previous astronomy, to which, in the 'Thema Cœli,' Bacon adds his own (*vide infra*, chap. iv.) His "Essay on the Tides" must have been circulated before 1616, when Galileo put forth a refutation of it, himself substituting a theory, in its turn to be refuted. Two papers only remain of this period, which, though mere jottings, are of interest as the nearest approaches in form to the 'Organum,' and for remarkable sentences which they alone contain. On the "De Interpretatione Naturæ Sententiæ, xii." Spedding remarks that, of the rejected preparatory forms, it is the most remarkable for weight, condensation, and comprehensiveness, and that it still bears traces of the dramatic form of the "Redargutio," which the writer afterwards wholly discarded for the aphoristic or expository. It contains one of the strongest expressions of his over-confidence—"Scientia celeris, tempus tardi

partus est . . . non longum (fili) sed ambiguum est iter," —and a passage in which he throws distinctly doubt on the freedom of the will, "Qualis causa est fortuna[1] in universo, talis est voluntas in homine." The "Aphorismi et Consilia de auxiliis Mentis," in which the idea of imposing one nature on another is first prominent, contains one of the clearest definitions of "form"—"Qui autem unitatem naturæ in materiis dissimillimis comprehendit, is formas rerum novit."

The 'Novum Organum' appeared in 1620. On this, the last product of Bacon's political prime, there followed, during the years of his retirement, other works which helped to fill up its gaps. First in order came a fragment of the enlarged 'Natural History,' dedicated to Prince Charles, with a "History of the Winds," and lists or sketches of subjects to each of which the writer had resolved to give the labour of a month. To one of these, "Life and Death," he devoted an extensive and, from the light it throws on his own character as on the beliefs of his age, most interesting treatise published in 1623. In the same year appeared the 'De Augmentis Scientiarum' and the metaphysical treatise, 'De Principiis atque Originibus,' as appears from references to the 'Organum,' after 1620. According to Rawley,[2] 'The New Atlantis,' and the 'Sylva Sylvarum,' the

[1] *Vide* 'Novum Organum,' i. 60: "Fortuna nomen rei quæ non est."

[2] The following is Rawley's list of the works mainly composed during the last five years of Bacon's life—*i.e.*, 1621-1626—Henry VII. and beginning of Henry VIII.: 'De Augmentis,' 'New Atlantis,' Dialogue on Holy War, Paper on War with Spain, Treatises on "The Winds," "Life and Death," "Dense and Rare," "Heavy and Light," "De Magnete," "De Luce et Lumine," translation of Psalms, last edition of Essays, revision of 'De Sapientia Veterum' and the 'Sylva Sylvarum.'

History of Henry VII., 1622, and the last edition of the Essays, 1625, complete the list of Bacon's great works.

In the 'Distributio Operis' that follows the preface to his 'Organum,' Bacon clearly sets before us the scheme of what he meant the 'Instauratio Magna' to be. It was to consist of six parts:—

I. Partitiones Scientiarum.—A survey of the pre-existing sciences, physical and mental, designed to be no mere summary, but to record the deficiencies in the previous knowledge of mankind, and suggest the means of supplying them. The promise of this part is fulfilled in the 'De Augmentis' and the 'Globus Intellectualis.'

II. Ratio Inveniendi, the true Method of Interpreting Nature.—The treatment of this part is less than half exhausted. Bacon admits that he put forth his great torso, the 'Novum Organum,' because his days being numbered, he "would have it saved," and with the hope of enlisting the aid of others in the compiling of the "Natural History, which must be the foundation of a true and active philosophy."

III. Phænomena Universi.—A collection of facts from every field of experience, representing all the appearances and changes made manifest by Nature or by Art. On the practical exhaustiveness of this treasure-house of materials on which the New Method was to be employed, rested the validity of the whole. To this, with a draft of 130 Histories, Bacon has only contributed the heads of comparatively few discussions. (*Vide* sketch of Scheme.)

IV. Scala Intellectus.—A number of "types or models, placing before our eyes the process of the mind in the discovery of truth." The author's own compari-

son of those types to the diagrams of geometry has suggested that this part was designed to give an account of analytical investigation, as set forth by Whewell and by Mill in vol. ii. of his 'Logic.' But Bacon, as we know from the recurring simile of the "pair of compasses," regarded his own method as geometrical, and it is more correct to say that he here intended to present some chosen examples of its successful operation and of its results. It has been conjectured that the 'Inquisitio de Motu' may fall under this head, as might the inquiry into Heat, if detached from the 'Organum'; but the only undisputed contribution to it by the author is the 3d "Filum Labyrinthi" or "Scala Intellectus," — a porch to an almost empty house. It has been conjectured that the reference in this fragment to a Natural History already written points to its being subsequent to the 'Sylva Sylvarum.' This is inconclusive; but the reference helps to fix the meaning of the metaphor. "The beginning of the path has been marked in the 'Organum': entering upon it, the author has passed through the dark and tangled wood of Nature. It now remains to ascend to a more open and steeper region, from the wood to the mountain-spurs," to which he shortly adds the caution, "He who can restrain himself and climb step by step, and overcome the ridges of things as of hills, by unwearied patience, one by one, he will in due time arrive at the summits and peaks of Nature, where he shall have a calm rest and a fairest view, and a gentle slope downwards to good and useful ends." But to the mode of this downward slope he has barely referred.

V. Prodromi, or Anticipations of the New Philos-

ophy.—This part was meant to give results of reasoning on carefully observed phenomena, without the full use of the New Method; somewhat corresponding to the liberty given in the 'Organum,' under the phrase, "permissio intellectus." The preface to this sufficiently indicates the design. Towards the close we read: "It is clear to us that if any one of average mature powers will resolutely set aside delusions and begin to inquire anew for himself, he will penetrate far deeper into nature by the mere force of his mind and its guesses than by all sorts of reading, or musing, or disputing, even though he does not apply the complete apparatus nor follow the strict rules of interpretation." This part of his system —under which the speculations 'De Fluxu et Refluxu Maris,' the 'Cogitationes de Rerum Natura,' and the 'Thema Cœli,' if not the 'De Principiis,' is, Bacon says, to be regarded as interest given in lieu of the principal, which is—

VI. The PHILOSOPHIA SECUNDA SIVE SCIENTIA ACTIVA itself; to which nothing in his writing corresponds, unless we assign to it the half-imaginary, half-prophetic world of the 'De Atlantis.' "To perfect this last part," he himself confesses, "is above our powers and beyond our hopes. We may, as we trust, make no despicable beginnings—the destinies of the human race must complete it; in such a manner, perhaps, as men, looking only at the present, would not readily conceive. For upon this will depend not only a speculative good, but all the fortunes of mankind and all their power."

CHAPTER II.

'ADVANCEMENT OF LEARNING,' 'DE AUGMENTIS,' 'ESSAYS.'

THE 'ADVANCEMENT OF LEARNING' was, with the exception of the first edition of his 'Essays' (1597), Bacon's earliest publication. That he regarded it as a provisional sketch appears in various references—*e.g.*, in his letter to Dr Playfer, Margaret Professor of Divinity at Cambridge, requesting him to translate the work into Latin, in which occurs the familiar phrase: "Since I have only taken upon me to ring a bell to call other wits together, it cannot but be consonant to my desire to have that bell heard as far as can be." It is clear that Bacon, already planning his work on a larger scale, published his two popular books to enlist the sympathy of general readers, and especially of the king, in his undertaking. At a later date, as appears from the dedication of his 'Dialogue on a Holy War,' pressed by the urgency of devoting himself to the 'Natural History,' he determined, after the composition in retirement of his 'Henry VII.,' to be satisfied with having rendered into Latin, under his immediate superintendence, what he had already written, as "some preparative or key for the better opening of the 'Instaur-

ation,' because it exhibits a mixture of new conceits and old, whereas the 'Instauration' itself gives the new unmixed." "The translation," he continues, "is to have ample[1] additions, especially in handling the partition of the Sciences, and so to quit his promise in that part."

The First Book of the 'Advancement of Learning,' to all intents identical with the first of the 'De Augmentis,' is, next to the 'Essays,' justly the most familiar of the author's works. There could be no more adequate prelude to the 'Great Instauration' than this exaltation of the Dignity of Knowledge, in language only rivalled by the advocacy of Freedom of Speech in the 'Areopagitica.' Nowhere does Bacon, in the fore-front of his age, more suggest the thought that, while the morning broke on all statues alike, Memnon alone made music in reply. Nowhere does he assert himself as an orator of science more persuasive, if not greater, than either Leonardo or Galileo: nowhere has he given more conclusive answers to the imputation of narrow if not sordid utilitarianism, preferred against his name by those who have taken it to their market, without more than a glance at his work. In face of Macaulay's implication that the Baconian Logic can lead us no further than to shun "mince-pies": in view of Hegel's sneer that we may expect from the nation that speaks of Bacon's "philosophy" to hear of "a philos-

[1] Besides expansion to more than twice the length, the 'De Augmentis' differs from the 'Advancement' in the following particulars: History and Natural Philosophy are differently divided; the treatment of science is amplified, that of English history curtailed; all allusions likely to offend Roman Catholics are omitted. Bacon, intending his work for circulation in Italy, says, "I have been mine own Index Expurgatorius."

ophy of cookery," it is worth while, even in our limits, to quote two exculpatory passages; because, no mere flourishes of rhetoric, they are indicative of the author's more or less consistent design and uniform mode of thought. He is speaking in 'The Advancement,' in terms repeated in the 'De Augmentis,' of the errors and misunderstandings that have retarded the progress of really productive thought:—

"But the greatest of all the rest is the mistaking or misplacing of the last or furthest end of knowledge. For men have entered into a desire of learning, sometimes upon a natural curiosity and inquisitive appetite, sometimes for ornament and reputation, and sometimes to enable them to victory of wit and contradiction; and most times for lucre and profession; and seldom sincerely to give a true account of their gift of reason to the benefit and use of men,—as if there were sought in knowledge a couch whereupon to rest a searching and restless spirit; or a terrace for a wandering and variable mind to walk up and down with a fair prospect; or a tower of state for a proud mind to raise itself upon; or a fort and commanding ground for strife and contention; or a shop for profit or sale, and not a rich storehouse for the glory of the Creator, and the relief of man's estate."

Further on, he writes:—

"I do not take upon me to obtain by any perorations or pleadings of this case touching learning, to reverse the judgment either of Esop's cock that preferred the barleycorn before the gem; or of Midas, that being chosen judge between Apollo, president of the Muses, and Pan, president of sheep, judged for *plenty;* or of Paris, that judged for pleasure and love against wisdom and power: for these things must continue as they have been, but so will that also continue whereupon learning hath ever relied as on a firm foundation that cannot be shaken—*justificata est sapientia a filiis suis.*"

Elsewhere, in the same spirit, Bacon declares, "It is a corrupt judgment to think that there are no true differences of things but according to utility." On the other hand, he thus ('Advancement of Learning,' II. xxv., 'De Augmentis,' B. VII.) clenches his divergence from the ancient and medieval schools :—

"Pompeius Magnus, being on a commission of purveyance for a famine at Rome, and being dissuaded by his friends not to hazard himself to sea in so rough weather, said only to them, 'necesse est ut eam, non ut vivam.' . . . This decideth the question regarding the preferment of the Contemplative and Active life, and decideth it against Aristotle. For all the reasons which he bringeth for the contemplative are private, and respecting the pleasure and dignity of a man's self: not much unlike to that comparison which Pythagoras made for the gracing and magnifying of philosophy; who, being asked what he was, answered 'that if Hiero were ever at the Olympian games, he knew that some came to try their fortune for the prizes, and some came as merchants to utter their commodities, and some came to look on, and that he was one of them that came to look on.' *But men must know that in this theatre of man's life it is reserved only for God and the angels to be lookers-on.*"

This is Bacon's "Philanthropia," which he supports by reference to the Scriptures, and applies to the whole range of physical as well as mental science, holding, that men are the investigators, that they may become the mimics of nature. His philosophy was half practical, half speculative. On the one side we have his schemes for making gold, his healing-draughts and preservatives, represented in later times by Davy lamps and vaccinations; on the other, his almost abstract

conception of "Form." He left the contemplation of the stars in their courses, to inquire into the agencies which more directly affect man's life; but he wished to find general and not special agencies. What Macaulay has said of the contrast between his aim and that of the ancients can only be accepted with serious reservations. When the old mythology had become an artistic fossil, Philosophy was as a Religion to the higher minds of Greece and Rome. Bacon never ceases to offer homage to Religion: he admits its influence, its necessity, its divinity. "I had rather believe all the fables in the Legend, the Talmud, and the Alcoran, than that this universal frame is without a mind." He offers incense without reserve on the altars, but his mind dwells outside the temple. "These things have I passed over briefly, for I can find no space or ground that lieth unsown," is his note, save on the political aspects of theology. Socrates brought down philosophy from heaven to earth. Plato restored it to a communion with the transcendental ideas among which his followers mainly dwelt. Descartes and Bacon again recalled it by widely diverse incantations. "Cogito, ergo sum," said the former: know thyself again, and clear the mind of prepossessions, and "eritis sicut Dei, scientes bonum et malum;" from which Spinoza drew the full conclusion. Bacon struck out another path, saying man must live, and to live must conquer, and to conquer must obey, and to obey must learn the ways of nature. It is philosophy come to correct thought, but also to stimulate invention. He was in part a utilitarian, not because he loved truth less, but man more. "Naturæ imperare parendo," means that our

art must be based on her procedure, our practical power on acquaintance with the working of her laws.

In the following he conveys his most general view of knowledge: "Science is the image of truth, inasmuch as the truth of Being and the truth of Knowing only differ as a direct ray of light does from a reflected one. The object of philosophy is threefold—God, Nature, Man. Nature presents itself to our understanding, as it were, by a direct ray of light, while God is revealed to us only by a reflected one,"—so striking the key of his opposition to Descartes, who gets at Nature through God, and not at God through Nature. On the one hand, we have the preference of "Experimenta Lucifera" to "Experimenta Fructifera"; on the other, of the *βιός πρακτικός* to the *βιός θεωρητικός*.

Our analysis of the 'De Augmentis,' in which 'The Advancement' is now merged, must restrict itself to an enumeration of the main heads of its nine Books, and a reference to the questions of most modern interest which they suggest.

I. Bacon's main contention is that recurring throughout the 'Organum,' that we may take heart for the future by noting the sources of ignorance in the past. Among these he dwells on "the disgraces that learning hath received" from the jealousy of "politiques" and the bigotry of priests, pointing out that (as shown by great examples of kings and statesmen) it has been, when wisely used, an ally rather than a foe of good government and of true religion. Under the head of "Vanities in Studies," his reference to "delicate learning" is of as close application in our days of "æstheti-

cism " *with* form and void, as it was in those of Euphues and Marini :—

"The admiration of ancient authors, the hate of the schoolmen, the exact study of languages, . . . did bring in an affectionate study and copie of speech. . . . This grew speedily to an excess, for men began to hunt more after words than matter ; and more after the choiceness of the phrase, and the round and clean composition of the sentence, and the sweet falling of the clauses, and the varying and illustration of their works with tropes and figures, than after the weight of matter, worth of subject, soundness of argument, life of invention, or depth of judgment."

Nor is there less aptitude in his characteristic protest against the degenerate tendency of mere specialisation :—

"After the distribution of particular arts and sciences, men have abandoned universality, which cannot but stop all progression. For no perfect discovery can be made upon a flat or level ; neither is it possible to discover the more remote and deeper parts of a science, if you stand but upon it, and ascend not to a higher."

II. Coming to the substance of his work, Bacon treats of Human Learning as resting on the division of the Faculties, and in the second Book discusses those based on Memory and Imagination—*i.e.*, History and Poetry. The former is subdivided into Natural and Civil, and under the first we have to note his view of the three phases of Nature :—

(1.) Free in its ordinary working—*i.e.*, in her regular processes or generations ; and here Bacon hints at the future development of Astronomy, Geology, Geodosy, and Zoology.

(2.) Free in errors, leading to the consideration of mar-

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vels which, in the forms of reputed sorceries, dreams, and divinations, he thinks worthy of more serious treatment than they have received,—"for it is not known in what cases and how far effects attributed to superstition participate of natural causes." This suggests the interesting question as to how far Bacon was ready to accept as true, alleged supernatural manifestations and occurrences. To what extent he believed in Astrology, Alchemy, Magic, and Witchcraft, it is difficult, perhaps impossible, to determine; for his expressions on the subject are conflicting. Some of these may be due to concession to the superstitions of his royal patron, more to the divided allegiance of a transition time. He never clearly accepts the reasonable scepticism of Cicero about the influences of the stars,—"What contagion can reach us from so great a distance?" or of Pliny, "Homer tells us that Hector and Polydamas were born on the same night. . . . Every hour in every part of the world are born lords and slaves." Nor does he, on the other hand, with Seneca, take the psychical effects of the planets for granted. His attitude is rather that of Tacitus, in reference to the so-called Chaldeans: "It is a class of men which in our city will always be prohibited and always exist;"[1] and again,—"For my own part, I doubt; but the majority of men will hold by the opinion that our fates are fixed at birth."[2] Bacon's contention seems, in the main, to have been the just one, that in most widely spread beliefs there is an element of truth exaggerated: *e.g.*, the Horoscope, the Ascendant, and the Houses of the Zodiac are fictions; but the heavenly bodies affect

[1] Ann., ii. 32. [2] Ann., vi. 22.

human life through atmospheric changes: there is no "evil eye," but influences beyond the ken of our philosophy "roll from soul to soul"; necromancy is an imagination or a trick; but there is a "natural magic" which, by the new use of natural means, can produce marvellous effects. On the whole, in common with many of his most distinguished predecessors and compeers — as Roger Bacon, Cardan, Tycho Brahe, and Kepler—he leant, in these matters, to the side of credulity; and if he may be excused for his lingering belief in Astrology, which did nothing to promote the true science of the stars, he may be almost justified in his half faith in Alchemy, which was the cradle of Chemistry, in essence less a false than a hasty anticipation.

(3.) Bound in Arts. The study of those which are mechanical is the best foundation for natural philosophy. Under the head of Civil History, he complains that there is yet no "History of Learning," by which "the literary spirit of each age may be charmed as it were from the dead;" for, without this, the rest is "as the statue of Polyphemus without the eye." The function of ancient history is, "to carry the mind in writing back into the past, and bring it into sympathy with antiquity." He denounces Epitomes as mere base and unprofitable dregs, and sets high store on the biographies and letters of great men. Passing to Poetry, in a passage worthy of Sir Philip Sidney's 'Defence,' as "that which bestows upon human nature those things which history denies it," he says it presents to the mind "a more perfect order and a more beautiful variety" than we can find in the real world, "correcting the inequalities of fortune and bringing refreshment

amid the satiety of common things." It is the eloquence of a man who had in himself all of the poet save "the passionate heart." The drama, he holds, which has "the stage for its world," may be made the means of a noble discipline, as "a kind of musician's bow, by which men's minds may be played upon:" but the highest kind of Poetry is parabolical, shadowing forth—as in the myths which, "as a breath from the traditions of more ancient nations, fell into the pipes of the Greeks"—secrets and mysteries of religion, policy, and philosophy, under the veil of tales and symbols. Bacon concludes the book with the fables of Pan, Perseus, and Dionysius, as in the 'De Sapientia Veterum.'

III. The third Book, which treats of philosophy as the product of the reason, is of special interest from the light it throws on some parts of the "Organum." Beginning with the division of its objects into God, Nature, and Man, Bacon first dwells on the fact that the branches of knowledge meet in one stem, and that there is a universal science, the mother of the rest, which he entitles "Philosophia Prima," or summary philosophy, concerned with general principles common to all special sciences. In illustration of these he instances the axioms of mathematics, and points out that they are applicable also to ethics; as shown in the Aristotelian discussion of distributive justice, where equals added to unequals result in injustice. In adducing similar concords between the rules of physics and politics, music, acoustics, &c., in which we may see "the same footsteps of nature treading or printing upon different subjects and matters," he is sometimes led away by his love of analogies. After treating slightly of Natural Theology, and assign-

ing to it the evidences for the being, power, and goodness of the Deity, as well as the nature of angels and evil spirits, he divides Natural Philosophy into the inquisition of causes and the production of effects. In the one case we ascend from experiments to "axioms" (used here, as in the 'Organum,' in the sense of inducted general truths); in the other we descend from "axioms" to the invention of new experiments. When the causes inquired into are transitory[1] and in motion, they are the objects of physic; but when they are abstract and fixed, and presuppose a mind and idea, the science assigned to them is metaphysic. After a confusing crowd of subdivisions, there follows a passage of remarkable interest on the lack of physical inquiry hitherto apparent in Astronomy. Astronomers, he says, have brought us the ox of Prometheus, a beautiful hide but stuffed with straw. They have arranged skilful systems on the basis of mathematical calculation, to resolve the visible phenomena into circular movements, but they have neglected to ask the cause of the phenomena. The interior of the ox (namely, the physical reasons) is wanting, "out of which (with

[1] Aristotle, *τά ἐνδεχόμενα* and *τά μὴ ἐνδεχόμενα ἄλλως εἶναι*. Much of the book, and Bacon's writing generally, is, despite his disclaimers, distinctly Aristotelian. He also assigns to this "Prime Philosophy" the consideration of what he calls essences or transcendentals, as much little, like unlike, &c.—relations elevated into distinct objects of investigation, after the manner of the ancient schools. Some of the axioms under this head, as "things agreeing with a third agree with each other," are analytical; others, as "Quantum naturæ nec minuitur nec augetur," founded on our notion of Substance, are synthetical *a priori* truths; while others, as those regarding the relations of the organs of sense to optical instruments, are mere analogies.

the help of hypotheses) a theory might be devised which would not merely satisfy the phenomena, but would set forth the substance, motion, and influence of the heavenly bodies as they really are." This is precisely what Newton, working on the data of Kepler, really did; and, in a subsequent paragraph, Bacon, suggesting that the discovery is to be made by obtaining information of heavenly things from those seen amongst ourselves, comes still nearer in his anticipation. But he rarely "dips into the future" without immediately reverting to the past; and in the next section he professes to retain a limited belief in astrology—not as "a revel among the stars," but in the influence on human life of their great processions. Later on, after one of his tiresome lists of dichotomous qualities which he calls configurations of matter, and a recommendation of a history of popular errors and of the progress of philosophy, we come to the discussion of forms and final causes that may be most conveniently collated with the corresponding passages of the 'Organum' (*vide infra*). The book ends with a definition, so far accurate, of pure and mixed Mathematics.

IV. Man, according to Bacon not being a part of Nature, has reserved for him a special investigation; and the fourth Book treats of his body and mind, both from a physiological point of view. This section, though full of interest from its dealing with a subject which engaged so much of the author's attention, may be passed over lightly as lying outside his system. The doctrine of "the League" between body and soul introduces reflections, often subtle, as to the relation of Physiognomy to Character. Chiromancy, on the other

hand, he declares a vain imposture; while as regards Phrenology, and the allocation of special passions to particular organs, he is in doubt. Of the arts concerning the body, the chief place is, of course, given to Medicine, to whose professors Bacon assigns a high dignity; their office being to regulate "a musical instrument of much and exquisite workmanship[1] easily put out of tune;" but he objects to their frequent empiricism and tendency to treat all their patients alike, which Hippocrates is praised for avoiding. Some of the lacunæ he notes in the art are remarkable,—as the recommendation to study comparative anatomy, to practise vivisection on animals, and to consider it part of their duty to "avert the dolours of death" by procuring Euthanasia. Bacon dwells on the prolongation[2] of life: "for though to a Christian, making for the Land of Promise, the world is but a wilderness, yet even while we travel in it, to have our shoes and garments (that is, our bodies) not worn out by the way, must be accounted as a gift of divine grace." On the head of "Athletics" he hints at their possible excess; and, disdaining arts voluptuary, after the manner of Plato, refers only in a few sentences to Music and Painting. His Psychology is that of Lucretius: the rational soul (animus) is divine; the irrational (anima), the breath of life and the sense which we share with the brutes, is a part of the frame. He desiderates a better explanation of Voluntary Motion, but merely touches on the distinction between Sensation and Perception; ending with

[1] Cf. "Hamlet," Act III. sc. iii.

[2] This book should be compared throughout with the longer treatise "On Life and Death."

the expression of a wish for further investigations into the nature of Light.

V. Bacon next sets forth his view of Logic, the rule of our understanding, as Ethics[1] is of our will and affections, "altera decreta, altera actiones progignit," and extends its province, with Ramus, over the ground commonly assigned to Rhetoric. There are, he says, four rational arts—that of Inquiry or Invention, Examination or Judgment, Memory and Tradition; and then complains that discoveries have hitherto been made by an instinct like that of the animals. Yet even this is better than the old Induction, which is a mere hasty conclusion from a number of particulars, without regard to contradictory instances. The syllogism only avails for argument: it consists of propositions, and these of mere signs for popular notions; whereas in Physics we wish to command nature, whose subtilty is greater than the subtilty of words. The failures of the past have given rise to the Academic assertion that we can only know appearances; but the sceptics have erred in laying the blame on the senses instead of on the wandering and contumacy of the mind. We require a new Art of the *Interpretation of Nature.* Reserving this, of which he says so much, and with which he does so little, for the 'Organum' itself, Bacon proceeds to offer a number of suggestions for his *Experientia Literata—i.e.*, varying, extending, and applying experiments; in what he calls the Hunt of Pan,—confessing this to be hardly a philosophic Art, but a kind of sagacity,—the sagacity, indeed,

[1] In discussing the function of the imagination as an agent of both, he again follows closely in the steps of Aristotle—*vide* Ethics, Book III. 1-3.

on which the real progress of science has hitherto been destined to rely.

Again, in the list of those, often pedantically named, suggestions, we have anticipations of discovery "scattered like donatives among the people," in the sciences of heat,[1] mechanics, and optics, along with world-old ideas of the affections of gravity and levity, great masses abhorring motion, &c. As regards the search for arguments, Bacon advises orators and advocates to have a ready-made supply, as the shoes in a shop, in what he calls the Promptuary. He commends the Aristotelian "Topics" as heads for argument or investigation, and adduces, in illustration, the main questions to be asked in an inquiry into the nature of "heavy and light." Speaking of Judgment, he leaves the syllogism with the remark that it has "been beaten over and over by the subtlest labours of men's wits," and "is but the reduction of propositions to principles in a middle"—meaning, apparently, that the middle is the means of resolving the minor into a major, with a difference. Then, after a reference to sophistical fallacies and those of interpretation, the latter being concerned with the cloudy use of words which is the sophism of sophisms, he concludes this section by his doctrine of Idols, and a few hints for strengthening and quickening the Memory.

VI. The sixth, as the fourth Book, given to a collat-

[1] Among Bacon's just remarks is that an unsuccessful is often as instructive as a successful experiment. In this Book he accepts the result of Galileo's experiment from the tower of Pisa, with a reservation, saying the two weights will take *almost* the same time in falling; and in one interesting passage he suggests the idea of a centrifugal balancing the centripetal force.

eral subject, may be briefly dismissed; though there is no section of the 'De Augmentis' of more occasional interest. Especially in the collection of Antitheta towards the close—a storehouse of thoughts and phrases, most of which we find incorporated in the final edition of the 'Essays'—we have a vivid illustration of the writer's habit of turning all questions on every side, and seeing what could be said in defence and attack of almost every proposition. Many of those adversative judgments representing the different aspects or real autonomies of life, "colours of good and evil," are so incisive on either hand, that they pull the reader's mind to and fro, like the reputed arguments of Carneades. In the main part of the book, treating of Grammar and Rhetoric proper, some of the points to be noted are: his recognition of the function of Hieroglyphics, the Chinese alphabet, Gestures, the relation between languages and national character, Bacon's desiderating a comparative Grammar, his depreciation of Etymology, his just view of the form of verse as varying by rights with the subject, his well-timed protest against the practice (initiated by Spenser's friend, Gabriel Harvey) of trying to "train the modern tongues into ancient measures," and his conclusive refutation of the phonetic fallacy. After a few pages devoted to Ciphers, and an anticipation of Telegraphy, he handles the method of Discourse, —Magistral where precepts are laid down to be simply accepted by the vulgar, or Initiative where a doctrine is conveyed to the true sons of science. There follows a defence of Aphorisms, which, "not to be ridiculous, must be cut out of the heart and pith of the matter," interesting because of Bacon's own excessive use of

them; and then an exposition of the diversities of Method, "the architecture of the sciences," demanded by different themes—*e.g.*, Mathematics, as the simplest, being contrasted with Politics, as the most complex of knowledges,—as well as by different audiences. Metaphors and comparisons are defended as a means of gaining an entrance for truth not agreeable to ordinary presuppositions. A number of sophisms follow, with refutations often as sophistical as themselves, and the whole is wound up with some excellent remarks on Education.

VII. Nowhere is the unmetaphysical side of Bacon's mind more manifested than in his handling of Ethics, which is the subject of this short Book. When he wrote, modern metaphysics had not begun; but he turns away from, or almost wholly ignores, the speculations of the schools, with which he was familiar. Referring to Aristotle and the Stoics, he pays no more attention to their discursions on the freedom of the Will than to Abelard's morality in intention and in act. His theoretic Ethics are as superficial as his Psychology; and of Ontology, save as a basis for Physics, he had no conception. We have here mainly a protest, from the point of view of a philanthropic statesman, against the comparatively vague views of his predecessors, and the isolated character of the old ideals.

Dividing his subject into two heads, Bacon first enlarges on the Exemplar of Good, and decides, in an argument clenched by quotations already given, in favour of the active against the contemplative life. Following Aristotle in holding the good of the State to be greater than that of the individual, he has no

θεωρία to superadd. He holds that we are likest God when we live in charity with men; and, from this point of view, protests against the "fugitive and cloistered virtue" alike of Lucretius and Pyrrho, Epictetus and the medieval saints, who spent their time in tending their souls, as Herodicus did in mending his health. In support of his thesis he appeals to the analogy of nature (where the agent is always superior to the patient) and to experience, teaching that inertia of any sort begets such satiety that "for very weariness a man might wish to die." "Tranquillam degere vitam," without the "vigour of fruition," he reckons an insanity. To make life a *meditatio mortis* is to misconceive its aim. Better, says the heathen, "fortem posce animum mortis terrore carentem." As the term VIRTUE is applied to the state of a mind well composed in itself, so its condition when well framed towards others is DUTY —whether that common to every one as a member of a State, or that called into exercise in pursuit of a man's special avocation in life. He approves Plato's view (Rep., iii.), that it is well for men to join the wisdom of the serpent to the innocence of the dove; "so that we are much beholden to Machiavelli (to whom references in this and the next book are constant) and other writers who openly declare and describe what men do, and not only what they ought to do, . . . for bad men are apt to think that honesty grows of ignorance." "The fool receives not the words of the wise unless thou speakest the things that are in his heart." Is it, then, true, as said Jason of Thessaly, "some things must be done unjustly that many may be done justly"? No, answers Bacon—the reply is good—"Present justice is

in your power; for that which is to come you have no security." So much of the fruit of life; it remains to speak of its husbandry, the GEORGICS OF THE MIND: under which head, while censuring Aristotle for drawing pictures of ideal excellence, and never analysing the affections, from which our actions spring, Bacon himself does not attempt to analyse them. Instead, he submits practical precepts, many of which are memorable — *e.g.*, In attempts to improve your character, know what is in your power and what beyond it; set before yourself concrete exemplars in life, and even in fiction; "the poets and writers of history are the best doctors of this knowledge;" take upon yourself tasks neither too great, which dishearten, nor too small, which enervate; "bear with all your strength" (quoting Aristotle) "to the extreme contrary to your inclination; cherish the good hours of the mind. But," he adds, "the most effectual remedy to the reducing the mind unto virtue is the electing and propounding to a man's self good and virtuous ends of his life and actions;" this done, he need not set himself, like a carver, to make an image; but let his better nature grow like a flower. After a splendid passage on the moral transfiguration of a mind inflamed with charity, he accepts the charge of commonplace in his views; but his aim here is utility, not grandeur. "Great is the magnificence of the ivory gate, but the true dreams pass through the gate of horn."

VIII. The same want of system accompanies a wonderful wealth of practical wisdom in Bacon's treatment of the virtue of "man congregate," that is, Civil Knowledge. The restraint under which this book is

confessedly written, in some respects detracts from its value, and renders it incapable of comparison with the 'Republic' or 'Politics,' or even the 'Leviathan,' while its insight of detail can only be displayed in quotation. We look in vain for any theory of government, other than that conveyed in suggestions for its preservation, supported by the author's unfailing richness of allusion, and a blending of Greek, Roman, and Italian instances. Much of the treatise is occupied with comparatively extraneous matter, relating rather to the shifts of diplomacy and the conduct of affairs, control of countenance and manner, the reception of suitors and use of underlings, than to the building and guiding of a State. Bacon is so apt to disappoint us when he nears his goal, that his work may be said largely to consist of great introductions; and throughout the latter books of the 'De Augmentis,' with the strong crisp style of the 'Essays' we have the same excess of antithesis, aphorism, and reference. These, however, never fail to stimulate as well as instruct. The comments on the 'Proverbs,' which fill so many pages, themselves afford material for indefinite commentary; and there is something peculiarly characteristic of the writer in the idea of illustrating the counsels of Solomon by those of Tacitus and Machiavelli, and by his own experience in the Court of James. On the text, "Lend not thine ear to all words that are spoken," we have a gloss warning us against useless curiosity, even about things that concern us, in terms that display at once Bacon's cynical and his nobler side. "First there ensues vexation, . . . seeing all things human are full of treachery and in-

gratitude. And therefore if we could obtain a magic glass, wherein we might view all the enmities and all the hostile designs that are at work against us, it were better for us to throw it down at once and break it to pieces, for these matters are but as the rustling of leaves, and have short duration." The proverb, "A poor man that oppresses the poor is like a sweeping rain," suggests the familiar truth, "The oppression of a poor and hungry man is far more severe than that of a rich and full one. . . . A sponge when dry sucks in strongly, but not so when wet." "Be not righteous overmuch" (after a quotation from the 'Annals,' "there are seasons wherein great virtues are the surest ruins,") is explained to mean, in the mouth of Solomon,—who, "though he often notes what is bad, never enjoins it,"—that we should avoid not virtue, "but the vain and invidious affectation and show thereof." The "dead flies" of Ecclesiastes appropriately invite the reflection, "It is a very hard and unhappy condition of men pre-eminent for virtue, that their errors, be they ever so trifling, are never excused."

It is often a hard condition when men of the world are exposed to the censure of pedants. No part of Bacon's work has received from critics, who have made of his 'Essays' texts for a moral class-book, more undiscriminating criticism than the precepts which follow on "The Knowledge of Advancement in Life." It was a natural part of the plan of a book emphatically professing to be practical, to deal with this subject; and the writer, at once a satirist and a shrewd observer, has often illustrated the truism that perfect candour is not always the best policy. It is plain that those who

desire "to make the wheels of the mind concentric and voluble with the wheels of fortune," whose chief end is to "get on," do well "not to row against the stream;" not to say all they think; to keep their counsel; to avoid association with luckless men or causes; to mingle modesty and confidence, and shun over-meddlesomeness; to insinuate rather than push themselves to the front; "to profess to despise what they cannot attain;" to let their vices take colour from the nearest virtues, "dulness assuming gravity, cowardice mildness,"—even to remember the Spanish proverb, "Tell a lie and find a troth," or the Italian, "There is always less money, less wisdom, and less faith than men imagine." In defence even of these sometimes questionable precepts, we may appeal to one of the greatest metaphysical critics of Germany: "To reproach Machiavelli with immorality (his theme being to keep on a throne a prince girt by enemies), is the same as to reproach a fencing-master because he does not begin his instructions with a moral lecture against murder." But Bacon is at special pains to make it clear that, in those passages, he has been looking only to the "morality of consequences," and that he is conscious of a higher standard. As early as 1593, in the "Discourse on Praise of Knowledge," he anticipates the objections that have been brought against him. "I did ever hold it for an insolent and unlucky saying, 'Faber quisque suæ fortunæ,' except it be only uttered as a hortative or spur to correct sloth, 'Faber quisque ingenii sui' is more profitable," &c. In the 'Advancement of Learning' the same caveats appear, which are amplified in the 'De Augmentis'—*e.g.*, "Not, however, that learning esteems this Architec-

ture . . . otherwise than as an inferior work. For no man's fortune can be an end worthy of the gift of being that has been given him by God; and often the worthiest men abandon their fortunes willingly, that they may have leisure for higher pursuits. But nevertheless fortune, as an instrument of virtue and merit, deserves its own speculation and doctrine." "The divine glass in which we ought to behold ourselves is the Word of God; but the political glass is nothing else than the state of the world or times wherein we live." Elsewhere he protests against "the Sabbathless pursuit of fortune," and assents to Virgil (Æn. ix. 252), saying, "All virtue is most rewarded, and all wickedness most punished, in itself." In the same spirit the "Letter of Advice to Villiers" inculcates: "Refer your actions chiefly to the good of your sovereign and the country. . . . Men are born not to cram in their fortunes, but to exercise their virtues."

Neither Bacon's practical attitude nor his theoretic ethics were those of a Marcus Aurelius. He wrote, felt, and acted as an ambitious statesman, amid surroundings almost as corrupt as those of the Papal Court which gave a deeper dye to the cynicism of Machiavelli (whose influence on his mind has been but slightly exaggerated); he would have been more dishonest than he was had he wholly withheld the expression of his view, that "the politician, as such, must study human nature as it is, its vices with the rest, and take things as they are, not as they ought to be." But, unlike Machiavelli, he was often amiably inconsistent; for he was never deserted by the aspirations which the circumstances of his career tended to suppress; and, in his mind, "the elements were so

mixed," that it is almost impossible to determine their proportion. His habit was not to strike a mean between the higher and lower life, but to give an incisive voice to each in turn, in Antitheta which taken apart can hardly fail to delude his readers. Hence the special unfairness of separating those which give the worst from those which represent, with equal sincerity, the best side of his character—*e.g.*, on the familiar phrases, "Truth may come to the price of a pearl, . . . but it will not rise to the price of a diamond. . . . A mixture of a lie doth ever add pleasure," there follows his far more frequent refrain, "Howsoever these things are thus in men's depraved affections, yet truth, which only doth judge itself, teacheth that the inquiry of truth, which is the love-making or wooing of it; the knowledge of truth, which is the presence of it; and the belief of truth, which is the enjoying of it, is the sovereign good of human nature. . . . Certainly it is heaven upon earth to have a man's mind move in charity, rest in Providence, and turn upon the poles of truth." Compare similar antitheses in the essays on "Revenge," on "Simulation and Dissimulation," on "Wisdom for a Man's Self,"—"in many branches a depraved thing, it is the wisdom of rats, that will be sure to leave a house before its fall." It is the mere malice of detraction to say that the worldly view is the man; the loftier, "a mere tribute to convention."

In so far as he touches, which is but slightly, on its ideal side, Bacon regards Ethics as a handmaid of Theology: his answer to the question, How do we know an action to be right? is: By its effects, and "an inward instinct according to the law of conscience, which is a

relic of man's ancient purity." But what makes it right is the good of others, especially of the State—*i.e.*, the greater whole, of which the individual is a part. After a "Treatise Touching the Extension of Empire," nearly identical with the Essay on "The True Greatness of Kingdoms," the Eighth Book of the 'De Augmentis' ends with a series of admirable and authoritative suggestions, in aphoristic form, on the theory of the administration and codification of Laws. At starting, he remarks that there are "three fountains of injustice—namely, mere force, a malicious ensnarement under colour of law, and harshness of the law itself." These, and other evils, he proposes to remedy by a revisal of the whole Corpus Juris, not patching, as "from this ensues a torment like that of Mezentius, whereby the living laws are stifled in the embraces of the dead;" and lays it down that the end and scope of all laws is "no other than the happiness of the citizens."

We have seen what Bacon's practical Politics really were—*i.e.*, a perpetual application of the fifth precept of his 'Architect of Fortune.' "Imitate nature, which does nothing in vain. . . . In every action a man should have one intention so underlying another that, if he cannot obtain his wishes in the best degeee, he may yet be satisfied if he succeed in a second, or even a third; . . . for nothing is more impolitic than to be entirely bent on one action." Consistently with this attitude, he always writes as an English statesman, having in his mind the golden mean, "mediocria firma"; never as an idealist. But there had come to him, through the Renaissance, almost the exact idea of an Aristotelian state, modified by the Roman examples of Plutarch and Livy, the study

of Cicero's 'Letters,' and the experiences of the struggle between Italian tyrannies and republics, presented by Machiavelli and Guicciardini. His conception of the more or less hostile relation of one State to another was almost wholly Greek, especially in his views (to which we have before referred) on *Commerce*, as regulated by a sliding-scale of retaliatory restrictions—a view wholly antagonistic to Cosmopolitanism.

Comparing the "Essay on Kingdoms" with passages in the 'De Augmentis,' and the interpretation of the myth of Perseus, we find his attitude as regards *War* to vary only in degree: his belief being that it is a necessary evil, but not one of the greatest, and with many compensations; that the Spartans only went to slight excess in making the military strength of their citizens the aim of their training. Bacon's advice to England is always the same ('De Augmentis,' Book VIII.): "Security" (*i.e.*, in Shakespeare's sense) "is an ill guard for a kingdom. The seas are our walls, and the ships our bulwarks. . . . I, in my disposition and profession, am wholly for peace; . . . justice is the best protector of it at home, and provision for war is the best prevention of it from abroad." He follows the ancients in his idea of the relation of the various classes of the community within the State itself, in his disparagement of the tradesmen as *βάναυσοι*, his reliance on the nobility and yeomanry, belief in agriculture as the best of peaceful avocations—the mainstay of a nation; in his regret that indoor crafts cannot now be relegated to slaves; in his holding the mercantile theory of money as the standard of value. He is Platonic in assigning to the State the entire control of the Education, physical and

mental, of its citizens; the endowment and cultivation of the Arts; the limits to Religious nonconformity; the divisions of freehold Land; in his notion of an ideal Constitution, relying on the paternal government of a philosophic King. He is Aristotelian in his assertion that "envy in commonwealths is a wholesome kind of ostracism," and, above all, in his well-established principle, that different Constitutions are adapted to various conditions of life and stages of civilisation. Bacon's advocacy of colonisation belongs to an age of growing empire, and he urges the example of Rome in her readiness to widen the range of her citizenship. His strong assertion of authority—"a king must be both loved and feared, else he is lost"—in Politics, contrasts with his renunciation of it in Science. He is least modern in the dictum, that "the lowest of all flatteries is the flattery of the common people."

CHAPTER III.

THE 'NOVUM ORGANUM.'

TOWARDS the close of the 'De Augmentis' we are told that, in coasting the old sciences, the writer has only been tuning the harp of the Muses. The 'Novum Organum' itself, which, with its prayers, prefaces, plans, and dedications, was, on its publication, inaugurated with all the pomp of the author's Chancellorship, is the melody. Though containing little not to be found in germ at least, in Bacon's earlier treatises, it is the form in which, after twelve revisions, corresponding probably to the years of its composition (1608-1620), he was satisfied to convey the central ideas of his philosophy. That the work is best analysed not always in the actual but in the logical order of its parts, results from the often unmethodical arrangement of its constantly overlapping aphorisms. The First strikes the key-note of the whole, and its full import can only be realised when we have grasped the system which it introduces. "Man, naturæ minister et interpres, can do and understand only as he has observed the course of nature," means that we can accomplish nothing but by discovering her uniform laws, and adjusting cir-

cumstances so as to make their action free. "Natura non nisi parendo vincitur," implies that no effect can be produced without a knowledge of the cause: all we can do is to combine or sunder, the rest is an inner craft. "That art which you say passes nature is an art which nature makes." Man is Nature's interpreter when, through phenomena, he detects her "forms," the unseen mechanism behind the visible sign, the underlying fact that remains while its manifestations change and pass. Man is her minister, as he is her copyist in arranging things in her order. To attain the cause, we have to rise to axioms, the ὁδὸς ἄνω; to produce the effect, we must descend—the ὁδὸς κάτω—to works, recognising that a cause in speculation, in practice becomes a rule. But to reach this result, to adjust anew the balance of mind and things, "mentis et rerum commercium restituere in integrum," and so to make philosophy restore the golden age, there is need of a new "ratio inveniendi" which, steering clear of the mere observation on the one hand, on the other of isolated facts, and the determination to make them agree with preconceived theories, shall find the laws or reasons of things hidden from the old Dialectic.

Bacon's remarks on the existing Sciences and the Logic of the schools (Aphorisms, 5-37) repeat in other words the censures we have before endeavoured to condense. The former are sterile, for they have but decked out chance discoveries by compilations and glosses; the latter, useless for works, has only set its seal on error, giving no account of first principles, which are to it ἀμέσοι προτάσεις: it can only reason down from notions harshly assumed; in which. when we attempt

to rise above mere surface-impressions, there is no soundness. Thus the syllogism catches assent, but lets the things slip through. "I leave," he says in the plan of the work, "to the old demonstrations their rule over popular arts, 'civilia et artes quæ in sermone et opinione positæ sunt;' but in dealing with the nature of things I use induction throughout." In Aphorism 19 the old and the new way are succinctly contrasted. The one impatiently flies from particulars, useless because vague generalities; and, taking the truth of these for granted, proceeds to invent principles of less generality, but more practical bearing. The other derives "axioms" from observation and experiment by a gradual and unbroken ascent, so that it reaches the most general axioms last of all. This is the true way, yet untried.

The partial truth in the sentence, "qui tractaverunt scientias aut empirici aut dogmatici fuerunt," and its exaggeration, is manifest in a survey of the previous philosophies thus condemned. The new method, which was to take progress from the circle in which it had been revolving, and make it end in discovery, was, according to Bacon, a kind of Logic, but it differed from the common logic in three respects—

(*a*) In its end; seeking "non argumenta sed artes."

(*b*) In its means; rejecting the syllogism, and avoiding hasty generalisations.

(*c*) In its start; assuming nothing as true without verification by experiment, and experiment conducted with a view to truth, not in the erratic manner of those who have sought too hurriedly for results, forgetting the divine order, which in the Creation set light before life.

After these introductory propositions Bacon's first

step is preparatory. The "intellectus sibi permissus" is not to be trusted: it is liable to all the errors of the old sciences and logic. He does not believe that the human mind is full grown in reason: he holds that, like a child, it must creep before it walks, and begin to walk on crutches. "Meus jam, ab ipso principio, nullo modo sibi permittatur, sed perpetuo regatur." Man is not the measure of things, howbeit they are destined for his use. Our *Sense*, in the first place, is defective; there are countless things too fine or too remote for it. Many minute bodies escape the eye, or things that move as fast as a bullet, or as slow as an hour-hand: interposing bodies intercept sight and sound, and the senses often clash: they require such aids as those described in the 'New Atlantis.' Then, the *Understanding* is not a dry light, but "receives an infusion from the will and the affections." Bacon ranks the disturbing causes which distort our view first under two heads: the Acquired, that come from dogmas and wrong modes of reasoning; and those Innate to the Intellect itself; which, like a broken mirror, deforms the faces of things. He more fully describes them as four "phantoms of the mind": reverence for authority; common talk or popular opinion; a lawyer's or a politician's bias, which he knew in Coke and Cecil; lastly, the interest and passion which coloured the "dry light" in his own as in all minds. These are the Idola "placita quædam inania," which are to science as fallacies are to logic, the *primâ facie* pitfalls in the way, the duties of omission in natural philosophy. As Bacon devotes a large part of the first book of the 'Organum' to an analysis of these Idola, it is desirable, even in a brief outline, to notice them more fully.

First, he discusses the *Idola Tribus*, or predispositions which more or less beset every one; for "the mind of man drawn over and clouded with the sable pavilion of the body, is so far from being like a smooth, clear, and equal glass, that might sincerely take and reflect the beams of things according to their true incidence, that it is rather like an enchanted glass full of impostures."[1] We are warped by the strength of first impressions, and having adopted opinions, hold them tenaciously; or we look only to affirmatives and not to negatives. "It was a good answer that was made by one who, when they showed him hanging in a temple a picture of those who had paid their vows on escape from shipwreck, asked, 'But where are they painted who were drowned after their vows?'" We are prone to assent or dissent without due suspension of judgment. "The understanding is unquiet; it cannot stop or rest, and still presses onward, but in vain: it runs into subtilties and refinements and endless inquiry." The eye is not satisfied with seeing, nor the ear filled with hearing. We suppose that nature acts as we do, which is a false analogy:[2] we presume there is more

[1] Cf. Locke. Men do not look through glasses which represent images in their true forms and colours, for they put coloured spectacles before their eyes, and look on things through false glasses, and then think themselves excused in following the false appearances which they themselves put upon them. The meaning of the term "Idola" is made clear in the 'Delineatio,' where Bacon writes: "In seeking for light, if the mind were an even mirror it would reflect correct images; but, being unequal or like an enchanted glass full of superstition and imposture, it gives false reflections=Idols. Until it is made even to receive divine ideas, it is full of 'larva' and 'incantata.'"

[2] *Vide* Brown's Discussion of Cause and Effect.

regularity in the world than there is; and so, determining all cases by the same rule, are diverted from the truth by an excessive love of uniformity.

Bacon then discusses the *Idola Specus*, peculiar to individuals,—"for every one (besides the faults he shares with his race) has a cave or den of his own, which refracts and discolours the light of nature. Whence it was well said by Heraclitus, that men look for sciences in their own lesser worlds, and not in the greater or common world." These Idola take their rise in peculiarities of mental or bodily structure, in education, habit, or accident. Among them are professional zeal, the narrow devotion of men to certain studies, "either because they have bestowed much thought on them, or, as it were, have lived all their lives in the midst of them. So Aristotle turned the world into a syllogism, the race of chemists into a laboratory; while Gilbert looks upon it as a mighty magnet: similarly with all systems that have a catch-word, and make that the pivot of the universe. We cannot be content to add things recent without rejecting the old. Surely the advice of the prophet is the true direction: "State super vias antiquas et videte quænam sit via recta et bona et ambulate in eâ. Antiquity deserveth that reverence that men should make a stay awhile, and look about to discover which is the best way; but when the discovery is made, then to make progression." Some love the old, others the new; some attend to minute points, others prefer large objects. The distinction between the legal minds that are keen to see varieties, to split meanings, and the theological that enhance resemblances; between the acute and

subtle and the lofty and discursive faculty,—is one of the most real in the book. Equally according to experience is the remark, that both err in excess "by catching the one at graduation, the other at shadows."

The *Idola Fori*, "omnium molestissima," are those of society and language. These Bacon calls delusions of "the market-place," on account of the commerce and consort of men there. They have crept into the understanding through the alliance of words and names. "For men believe that their reason governs words; but it is also true that words, like the arrows from a Tartar bow (*vide* 'De Augmentis,' Book V.), are shot back, and react on the mind." The names which give rise to Fallacies are of two kinds: those applied to things "which do not exist, as fortune, the *primum mobile*, planetary orbits, the element of fire, and like fictions which owe their origin to false and idle theories;" or those of things which do exist, but of which our conceptions are confused, whether actions as generate, corrupt, &c., or of qualities as humid, heavy, rare, dense, &c.

Lastly, there are the false notions which have immigrated into men's minds from the dogmas of philosophers. These are called *Idola Theatri*, because all the received systems are "but so many stage-plays, representing worlds of their own creation after an unreal and scenic fashion." Bacon's criticism of this class of delusions is his criticism of the ancient and medieval philosophies, repeated from the 'Redargutio' and the 'Cogitata et Visa.' Under this head he gives a triple classification of false systems:—

1. *The Sophistical;* where dialectic subtilties are

built on common notions, represented chiefly by Aristotle, whom he again accuses of substituting formulæ for the investigation of nature, and, after destroying other sects by hostile confutations, laying down his arbitrary laws.

2. *The Empirical;* where theories are rashly educed from a few observations by men who, turning too eagerly from light to fruit, heap up isolated facts, and rely on random experiments.

3. *The Superstitious;* where theories of Nature are built on mystical traditions, represented by Pythagoras, and more subtly by Plato among the ancients; and by all who in more recent times confound theology and science, history and philosophy.

The same contrast between false and true philosophers is reproduced in the often tantalisingly tautological remainder of the book; in the course of which no protest is more emphatic than that against the Acatalepsia of the New Academy, and the more thorough-going Pyrrhonic Scepticism which "doomed men to perpetual darkness," and made them think the true differences of things are past finding out. Bacon himself started with a doubt of received opinions; but it was not the paralysing doubt of dogmatic negation,—it was (like that of Socrates in earlier, of Descartes in later times) the starting-point for a new construction—an Acatalepsia preparing the way for a Eucatalepsia. In grappling with the Idola,[1] he "met the spectres of the mind" and essayed to lay

[1] It is evident that those Idola may either act together or separately in the same mind and in reference to the same thing. If I say, "the sun moves round the earth," because my eyes tell me so, it is an Idolum Tribus; if because common language says so, it is an

them. Among the remedies against their influence which he has indicated is the memorable caution, "Let every student of nature take this as a rule, that whatever the mind seizes and dwells on with peculiar satisfaction is to be held in suspicion." Equally suggestive in reference to the motives that should guide us on the forward path is the distinction he draws between the "love of excelling" and "the love of excellence." Those who are led by the former may make good soldiers and servants of State, but only those who are true to the latter will make good princes or philosophers.

Following on the discussion of the Idola, Bacon notes their bulwarks: defective sense-impressions, notions ill drawn from them, induction without exclusions; whereas selection and not mere accumulation lies at the root of the new Logic. On this follows one of the recurring protests against utilitarianism in experiment; and then (Aph. 71-92), beating over often-beaten ground, a list of *five signs*, and *fifteen causes*, often cross-divisions, of the defects of the received sciences. Under the first head, he observes that their origin with the Greeks was unpropitious, their progress slow, and their fruit scanty, introducing his image of time as a river that drowned the more solid systems of Heraclitus and Democritus, and carried down on its surface the lighter planks of Aristotle and Plato. Under the second he dwells on the shortness of the propitious periods; for during all the middle age the Arabians and Schoolmen rather crushed the sciences by a multi-

Idolum Fori; if because Ptolemy says so, it is an Idolum Theatri; if because that view agrees with other theories of my own, as was the case with Bacon himself, it is an Idolum Specus.

tude of treatises than added to their weight; the neglect of Natural Philosophy, "the great mother of the Sciences," which have been torn from her womb and so severed from their root; waste of time in unprofitable talk; reverence for "the world's youth;"[1] a lazy content with discoveries already made; the quackery of magicians and the habit of limiting investigation to one subject, as the magnet, the sea, the heavens, of which Bacon, in the wide range of his ambition, did not realise the need. He ends his list with his prevailing note—that of the herald, bell-ringer, and trumpeter of the race: "The greatest obstacle to progress is that men despair and think things impossible,"—and then passes to the grounds of Hope (Aph. 92-115).

After a characteristic appeal to prophecy, he maintains that our knowledge of the errors of the past, as arising from the divorce of the experimental and reasoning faculties, is an argument for trust in the future. We have now a better understanding of the true functions of Philosophy, which must no longer be subservient either to Logic or to Mathematics; we have the beginnings of a more extensive Natural History, and new helps to making it profitable,—a result which will be achieved if we do not sever the sciences from their stem, and discard the common childish induction by simple enumeration, whose conclusions, exposed to the refutation of a single negative, are precarious. Everything may be expected from the new method when we consider what has been done without it. Living in the

[1] To previous instances of the use of this phrase we may add that of Otto Casmann. It has been traced to Esdras. "The world has lost its youth, and the times begin to wax old."

wake of such a series of discoveries as gunpowder, silk, the mariner's compass, and the printing-press, in the fresh air of the breezes of hope that blow upon us from the new world, we need never speak of impossibility. That which men have done is "but earnest of the things which they shall do." Bacon concludes the Pars Destruens of his book, and sums it up as mainly consisting of three refutations, which may thus be tabulated in reference to the *Idola* :—

1. Redargutio Philosophiarum, refutation of received theories,	*Idola Theatri.*
2. Redargutio Demonstrationum, refutation of wrong modes of reasoning,	
3. Redargutio Rationis humanæ naturæ, refutation of the natural and unaided, and therefore illegitimate, workings of the mind,	*Idola Tribus, Specus.*

The *Idola Fori* may be considered as falling under both heads 2 and 3.

He concludes his first Book (Aph. 116-130) by answers to objections, and further hints of his design. He is no founder of a sect; nor does he think it much matters what one may think, with or against Telesio, as to the principles of things. His purpose is to lay more firmly the foundations of man's power; and though he has collected a number of results for the *fifth part* of the 'Instauration,' he has "no entire or universal theory to propound." His Natural History, which is the *third*, and his Tables of Discovery, which compose the *fourth part*, are incomplete and insufficiently verified; but, in weak health, and trammelled by affairs, he has

yet made some advance. All errors may be corrected when their causes have been discovered, but prejudices must be set aside; and we must not shrink from our task because it may bring us in contact with things called mean and apparently trivial. There is nothing mean in nature: we cannot measure use by show: "quicquid essentiâ dignum[1] est, id etiam scientiâ dignum, quæ est essentiæ imago." Despise no detail—"Sol[2] enim æque palatia et cloacas ingreditur, neque tamen polluitur." Nor are the matters we are called on to consider too subtle, for things apparently useless often teem with fruit,—"the knowledge of simple natures well defined is light;" nor commonplace, for they are keys to what is rare. As to presumption, surely there is none in saying that we can draw a better circle with a pair of compasses than without them. The theorists and fabulists of the past drew up far conclusions by logic as wheels draw water from a well, "whereas I pledge mankind in a liquor strained from countless grapes." The new, like the old logic, when complete, will apply (Aph. 127) to all the sciences. "I form a history and tables of discovery for anger, fear, shame, and the like; for matters political; and again, for the mental operations of memory, composition, and division, judgment and the rest, not less than for heat and cold, light or vegetation, though the method of invention may be somewhat modified

[1] Cf. Plato, Parmenides.

[2] Cf. Shakespeare, "Winter's Tale," Act IV. sc. iii. :—

"The self-same sun, that shines upon his court,
Hides not his visage from our cottage, but
Looks on it alike."

according to the subject of the inquiry." Though it be still defective, the end is such that, *magna præmia*, it is worth a trial. Meanwhile much may be done even by the methods in vogue. If we pursue our researches in order, and keep the sciences close to nature, we may begin with Alexander's heart.

One of Bacon's devices for attracting attention was to startle. He begins the Second Book of the 'Organum' by a sudden enunciation of the most obscure part of his philosophy. "On a given body to generate and superinduce a new nature or natures is the work and aim of human power"—*i.e.*, man is *minister naturæ*. "Of a given nature to discover the form, or true specific difference, or nature engendering nature, or source of emanation, . . . is the work and aim of human knowledge"—*i.e.*, man is *interpres naturæ*. To understand this, which may have provoked the criticism of King James, we have some way to travel, and it seems best to start from the step which Bacon proposed to take after his road was levelled and ground cleared. In logical as well as practical order, that first step was to make a complete list of the *Phœnomena universi*, to which he calls attention in the Plan of the 'Instauratio.' In the "Parasceve,"[1] or preparatory essay published in the same volume at the end of the 'Organum,' that "it might be put out of peril," he dwells on the importance of this part of his scheme, declaring that without such a history nothing can be done, "if all the wits of all the

[1] This interesting paper is to some extent a repetition of 'De Aug.,' B. III., but Bacon adds new physical illustrations, and dwells on the necessity of, at least, a history of the cardinal virtues or leading forces of nature, as precedent to Interpretation.

ages had met or shall meet" in a world university. "Whereas let such a history be once provided, . . . and the investigation of nature and of all sciences will be the work of a few years. This, therefore, must be done, or the business must be given up."

Bacon's system hangs together: the possibility of carrying out his method of exclusions depended upon the completeness of the history. One of his fundamental conceptions, to all practical intent a misconception, was the finity of nature, which he regarded as a chess-board on a gigantic scale divided into definite squares. The notion of infinity in the modern sense—*i.e.*, as distinct from the indefinite ἄπειρον—is no more present to his mind than it was to that of the Greeks: for their finality he substitutes another of his own. Speusippus is reputed to have been the first to attempt a conspectus of the sciences, to have said that he who would define anything must know everything, and to have written ten books stating the resemblances of all things he knew. The revival of this attempt in the 16th century was natural to the overweening age whose new knowledge was vast, but vague and undivided, and those who received it as a whole did not recognise the complexity of its details. Like the old Ionic philosophers, though from another point of view, they tried anew to grasp the total bulk of things. While Sir Walter Raleigh was writing a history of the whole world, Bacon thought that he might put labels on the whole of nature. He did not know by how many parts her subtilty passes the subtilty of the human mind, or how many new instruments were needed to wring her secrets from her tenacious grasp; and his lists are a

jumble of things great and small—his instances and conclusions medleys of shrewd suggestion and almost childish fancies, or mistakes in meteorology, medicine, acoustics, optics, astronomy. But, like Galileo, he maintained that nature must be interpreted like a book, and that we must learn the alphabet—though far longer than he knew—before arranging the facts of an 'Historia Naturalis,' and so dealing with them as to construct a 'Scientia Naturalis.'

The accumulation of those facts, as a store-forest "particularum sylva et materia," is the administration to Sense referred to in the 'Delineatio.' The administration to Memory is supplied by arranging them according to a fixed principle, with a view to find the clue to their causes, in three Tables of Investigation, of which the first is—

1. *The Table of Affirmatives*—"Essentiæ et Presentiæ; Positivæ sive Convenientes." This is to contain a collection of all the known instances that agree in having the same quality. *E.g.*, if the subject to be inquired into is heat,[1] of all bodies that give forth heat—as the sun, lightning, flame, burning-glasses, the blood of mammalia, living animals, hot iron, &c., &c. The use of this table is to show the error of attempting to discover the nature of anything in the thing itself, because the true cause must explain all the known effects. We are advised, in forming it, to collect instances from all quarters, and from varied and dissimilar objects. This

[1] This is, of course, the subject selected by Bacon in the 'Organum' in place of motion, as designed in the 'Filum Labyrinthi,' probably from his having come to the conclusion that motion was itself a "simple nature."

being done, it approaches the least exact of the experimental methods whose canon is thus laid down by Mr Mill: "If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree is the cause (or effect) of the given phenomenon." But any conclusion arrived at from an inspection of this table will be a guess; for Bacon curiously remarks, only God and the angels can tell the cause from the contemplation of the affirmatives. The human mind must make use of—

2. The second table of *Negative Instances*, "Negativæ vel Contradictoriæ," also called that of Declination, or Absence "in proximo,"—a collection of examples of bodies otherwise similar (else the list would be endless), which do not agree in the same nature. Thus the negative table of Heat would contain such instances as the moon's rays, blood of fish, dead animals, &c. We are brought a step nearer to our discovery by setting aside whatever is non-essential or extraneous. The employment of this table along with the first corresponds in some degree to the "Joint Method of Agreement and Difference"[1] in modern logic, and corrects the premature generalisations that might be made from the Affirmatives alone. Thus, when it appears that the blood of terrestrial animals is hot and the blood of fish cold, the hasty conclusion that the blood of animals is hot is vetoed: so also the notion that Heat has its source in the heavenly bodies, or that it always accompanies Light by the fact (alleged by Bacon) that the moon's rays are cold. Another use of his table is, he tells us,

[1] *Vide* Mill, Logic, vol. i. p. 429.

"to discover the nature sought by observing some of its qualities that are absent in the otherwise analogous nature, like the images of Cassius and Brutus in the funeral of Junia, . . . eo ipso præfulgebant quia non visebantur." Thus boiling water is hot, ice is cold; living bodies are hot, dead bodies are cold: but in boiling water and in living bodies there is motion of parts; in ice and dead bodies they are fixed. Does it not seem, therefore, that motion of parts is of the nature of Heat? The stress Bacon lays on negative instances is one of the earliest applications to philosophy of the principle, "Audiatur et altera pars." He constantly urges that the cardinal defect of the old Induction was the neglect of this; that our conclusions can never be legitimate or secure till they have passed through the sieve of this table, and have no more to apprehend from an unforeseen exception. Then alone experience has ceased to be empirical, and become critical.

3. A third table is that of *Comparison, Majus et Minus—i.e.*, a collection of instances where the phenomenon sought to be explained is present in various degrees. Thus Heat is unequal in various kinds of flame, rising in degree from that of burning spirits of wine to that of a blast furnace: it varies in the same animals, under different circumstances; it is greater in boiling lead than in boiling water, &c. The use of this table is that of Mr Mill's "Method of Concomitant Variations," and its canon may be stated in the same way: "Whatever phenomenon varies in any manner, whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or is connected with it through some fact of causation."

This method, employed alone, often throws suggestive light on the relation of antecedents and consequents; but its efficacy largely depends on the skilful use of Experiment, in which Bacon, while recognising its importance, was in practice singularly deficient.

So far all is plain. These tables of Presentation, as they are called, and the use made of them, are rude forms of the modern laws of Induction. There is wanting only the recognition of Theory as a motive and principle of arrangement. Nor is Bacon without a vague idea of the value, at this stage, of conjecture or hypothesis as applied to the interpretation of the facts, which he expresses, in his own metaphorical way, under the name of the "Vindemiatio Prima" or "Permissio Intellectus"—*i.e.*, an indulgence to the understanding to gather early grapes. The image, as his images often do, carries its own fallacy in still underrating the importance of the part that has to be played by such tentative conjectures as those of Kepler, and such special investigations as those of Galileo, in the advance of discovery; but, as far as it goes, it is a concession to the methods since pursued in science. Proceeding on the basis of Mill's rule,—"Whatever circumstance may be excluded, without prejudice to the phenomenon, or can be absent notwithstanding its presence, is not connected with it in the way of causation,"—Bacon throws into a *preliminary Table of Exclusions* everything about Heat which is not present in the affirmative instances or which is present in the negative, everything which increases when the phenomenon decreases, and *vice versa*. From its possible causes he throws aside Light, Fluidity, and Quiescence, and arrives at his residue or result in an

approximation to the nature of the quality he wishes to decipher. Thus it appears that the essential nature of Heat is Motion. Flame is perpetually in motion; so are hot or boiling fluids. Heat is increased by motion, as in bellows and blasts; all bodies are destroyed, or have the position of their parts altered by heat; when it escapes, as in death, the body rests. Motion is therefore clearly the genus of Heat. Going further, in his conjecture, as to the true specific differences which limit motion and constitute it the Form of Heat, he concludes that it is a motion, "expansive, restrained, and acting in its strife upon the smaller particles of bodies—a motion which, while it expands all ways, has at the same time an inclination upwards." "If, therefore, in any body you can excite a dilating motion, and can turn it so back upon itself that the dilation shall not proceed equally, but have its way in one part and be counteracted in another, you will generate Heat." This conclusion, though attained by an imperfect process, and defective in detail, is surely not so far from announcing the principle of heat, which is often arrested motion, as critics, to whom detail is everything, have assumed.

But this is only the first vintage, beyond which, as a matter of fact, Bacon in none of his investigations was able to get. He had worked up to the modern canon of the method of Residues,—"subduct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents,"—but he failed properly to apply it. His course should have been, through further testing experiments,

to analyse the manifestations of one or two forces. But he was hurried on by the very impatience, misled by the same love of uniformity, which in his predecessors he denounced. Above all, he had set before himself an impracticable design. It must always be borne in mind that Bacon's idea of Induction was no mere index or guide, but a system as rigid as a mathematical problem, as certain as the operation of a natural law which was designed to do for the premisses of discovery what Aristotle had done for the conclusions of argument.[1] It was a formula for leading us to laws, without the possibility of a contradictory instance—laws which would lead us to fresh results in practice, by a process like moving the handle of a calculating machine. The ordinary Induction, he maintains, is like "chasing a quarry over an open country;" in the new it is confined within limits and brought to bay. Ruling the latter are two leading conceptions,—that of Form, as "the sole survivor of all the natures, combined with which the given nature was first presented to us" (a conception we shall presently discuss); and that of the strict *Method of Exclusions.* This Exclusion is not an assortment of facts sufficient to enable us, as in modern Induction, on a presumption of the uniformity of Nature, to infer the law; it is *a rejection of everything extraneous,* and thus the key of interpretation, the adequate "ministration to the Reason" foreshadowed in the 'Delineatio.' Confident at starting in the limitations of the park where he has to hunt his game, Bacon states his intention of running it down "per

[1] Bacon assuredly did not succeed in doing this, as Professor Fowler seems to assert he did.

omnimodum exclusionem," till all the rejections having been made, and Nature sifted in the fire of the mind (Aph. 16), "abeuntibus in fumum opinionibus volatilibus," all light opinions vanishing like smoke, there will remain at the bottom (as the mystic rose of Alchemy) the "true and solid cause." "It is only thus," he says (Aph. 17), "that the power of man can be emancipated from the common course of nature, and exalted to new efficients and new modes of life." Every exclusion is an added element of liberty, as it frees the mind from being bound to a nature which is not, and enables it to run in search of that which is, essential. At the close of the rejections about Heat, we are told, "All and each of the above natures do not belong to its Form, and from all of them man is freed in his operation."[1] But it is evident that *this process can only be exhaustive when the list of negatives is complete*,—that the possibility of its completion of the list depends on the practical finity of Nature. Another and a fatal flaw in Bacon's system seems to have been, at first dimly then increasingly, apparent to himself. He again and again insists that everything may be resolved into an aggregate of Simple natures, and admits (Aph. 19) that till we have a well-defined list of these, the Exclusives cannot be satisfactory. "This part is not at all complete, nor can it possibly be so at first; . . . for if we do not yet possess sound and true notions of Simple natures, how can the process of exclusion be made accurate?" Therefore he will

[1] *E.g.*, Whiteness, the instance given in 'Val. Ter.,' may be produced in various ways; but we "give the direction," which is otherwise fettered or chained to unessentials by rejecting them.

"not rest satisfied with the precepts laid down, but will desire and supply more powerful aids ('fortiora et ulteriora auxilia') for the use of the understanding." A similar promise is made (B. I., Aph. 14, 15, 16, 18) where, arraigning the vagueness of commonly received scientific conceptions, he says we must have "a better method of definition;" but the subsidiary reasoning processes confessedly required for it are wanting. Bacon has done little to fulfil these promises; his induction remains in need of notions which have "their only hope" from his induction; and we need not wonder that he has been charged with reasoning in a circle. His exact method failed, partly because it is impossible to make the formation of conceptions mechanical; because he did not recognise that science must progress by the application of tentative ideas[1] to facts; partly because Nature is practically infinite, and the best alphabet of the universe can only be that of the knowledge of a single age. It is hardly fair to say that he abandoned his Method of Exclusions; for we cannot tell to what the completion of the fragment of the 'Organum' (a fourth, according to some estimates of the original design) may have grown; but it is plain that he began to doubt his power of fitting the key to a lock for which it was in reality too small. He felt that he needed more help, not only from mental processes, but from other men; and fell back, with his habitual δευτέρος πλοῦς, on concrete examples, on contributions to the "royal work" of Natural His-

[1] These ideas are of two kinds: one, represented by Kepler's linking together the points in a star's progress by an ellipse, is a geometrical—the other, by Newton's law of gravity, is a physical—imagination.

tory at the base, and (as in the 'De Principiis') imaginations of his own regarding the clouds around the summit of his system.

In Aph. 21, Bacon gives a list of some of the further aids or *fortiora auxilia* to which (Aph. 19) he had referred. Among these, his proposal to vary the investigation according to the nature of the subject is a tribute to the true scientific method then employed by Galileo, and since adopted; the "Rectification" was probably meant to correspond to our "Verification"[1] of Inductions, "the Limits of Investigation" was like the impossible synopsis of the Universe, and the ascending and descending scale,—an anticipation of the Scala Intellectus, or exemplars of inductive processes and results. Of the nine heads, one alone is handled in the 'Organum'—that of *Prerogative Instances*. These are cases in which the law of which we are in search comes forward with such prominence as to merit or arrest our attention in a peculiar degree; as Sir John Herschel says, "Characteristic phenomena selected from a number that would confuse, presenting themselves in such a forcible way as to impress us with the idea of causation." Some of these seem to show the cause at a glance, and are as final as tests in chemistry; others are like the Instantia Crucis, equally decisive in arbitrating between two hypotheses,—as when the mind is in doubt between two causes (*e.g.*, whether the tides rise together or roll from shore to shore), it removes the one and leaves the other; many are analogies, pointing to research rather than themselves direct sources of knowledge.

[1] Several of these aids have been unfolded and illustrated with the lights of modern science by such writers as Whewell and Mill.

Bacon enumerates and illustrates at length, with more than his usual display of a physical knowledge at once copious and inaccurate, twenty-seven of these Instances, of which the following are the most important :—

1. *Instantiæ Solitariæ;* where the same quality exists in bodies different in every other respect, or where bodies, otherwise the same, differ only in respect of this quality. Thus, colour is found in prisms, flowers, rainbows, drops of dew, which are in every other respect unlike. The different parts of the leaf of a tulip agree in everything but the colour; flame and a heated stone differ in everything; a cold and a heated stone agree in everything except the heat. The use of these instances, having nothing in common but the nature we are examining, corresponds to the more exact use of the "Method of Difference" in recent Logic.

2. *Instantiæ Migrantes,* travelling instances; where the property in question is, as it were, caught coming into existence, or seen passing from one state to another. Thus, clean water and glass are transparent; if we freeze or agitate the water, or pulverise the glass, they become white—whiteness, as it were, comes upon the field. Masticating pepper and striking a light are instances of heat and light travelling into existence. Under this head are introduced some curious speculations about colour.[1]

3. *Instantiæ Ostentinæ,* glaring instances; where the nature sought appears in a peculiarly conspicuous manner. They show some property in its highest energy, as

[1] As in 'Val. Term.' Bacon says that equality of arrangement of parts produces transparency: uneven bodies are white, uneven and irregular black.

the expansive power of heat is shown in the thermometer, "vitrum calendare æris"; and quicksilver being heavier than the diamond, shows that weight does not depend on compactness.

4. *Instantiæ Manipulares.* Experiments, physical or mental, as aids to memory or sense, which help to discover hidden operations, or by "uniting natures"—*i.e.*, arranging facts in groups—"pave the way to forms."

5. *Instantiæ Conformes,* analogous instances; where one department of nature or phase of life seems to throw light upon another, presenting facts with a resemblance amid great diversity. Thus, the structures of the human eye, of the telescope, and of the microscope are analogous, as bearing on the power of sight. Gums and gems are exudations of juices, the one of trees, the other of rocks. So we may compare the hairs of beasts and the feathers of birds, &c.

6. Under the heads of *Instantiæ Monodicæ* and *Deviantes,* singular and deviating instances, he dwells on the importance of paying attention to the strange phenomena, apparent irregularities, and freaks of nature.

7. *Instantiæ Potestatis,* in which the power of human wit is shown in useful inventions, and the masterpieces and mysteries of any art which exerts wonder, "for wonder is the child of rarity. . . . Matters of superstition and magic should not be omitted, . . . for it may be that in some of them a natural operation lies at the bottom, as in fascination, sympathy of things at a distance, transmission of impressions from spirit to spirit no less than from body to body, and the like."

8. *Instantiæ Comitatus atque Hostiles.* These are instances of qualities always found together, as flame

and heat,[1] or never found together — *e.g.*, solids are never both transparent and malleable.

9. *Instantiæ Fœderis*, instances of alliance; where the same work is done or change wrought by causes apparently heterogeneous—*e.g.*, when the heat of fire, falsely supposed to be merely destructive, ripens grapes in the same way as the heat of the sun, supposed to be generative, we say that the difference between them is not radical—*i.e.*, they have the same form.

10. *Instantiæ Crucis.* Decisive when the mind is in doubt between two alternatives. Bacon's speculations on the tides, his astronomical hypotheses, a crude theory of projectiles, and a discussion of the polarity of the magnet, are here introduced.

11. *Instantiæ Januæ*, of the Gate, instances of direct aids given to the senses, are interesting from the reference to the possible light to be thrown by the microscope on the Atomic theory, and to the resolution of the Milky Way into stars by Galileo.

12. *Instantiæ Quanti—i.e.*, such as inquire into the proportion of the quantity of a body with respect to its virtue, of which, in the 'De Augmentis,' we have a suggestive though humorous example: "Men should remember the mockery of Æsop's housewife, who conceited that by doubling her measure of barley her hen would daily lay her two eggs; but the hen grew fat and laid none." It is the modern fallacy regarding education.

It only remains to note that under the head, *Instances of Strife*, which discuss the contending forces of nature,

[1] Bacon's instance, which only holds good on one side—*i.e.*, flame is always hot, but heat does not always flame.

we have what is practically a continuation of the "Filum Labyrinthi" in the discussion of nineteen kinds of Motion; and that the book concludes with an unfulfilled promise to expound the rectifications of induction, and then to proceed to concretes, latent processes, and configurations.

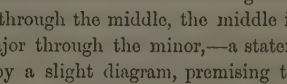
In Bacon's Tables and Instances, with a constant reference by way of caution to the Idola, and the use of the Experientia Literata, which he claims as a prerogative of modern times, we have as much of his method as he was enabled to expound. Its incompleteness is confessed, its defects manifest; but the contention that there is in it nothing new, that it is a mere restatement of common practice, is an *ignoratio elenchi*, which would lead us to conclude that, because the burnt dog as well as the burnt child dreads the fire, it is idle to inquire into the nature of heat, or that mensuration and trigonometry are useless because, for practical purposes, a man can find the length and breadth of most fields with his eyes and legs. Macaulay's jest about the Judge and the three names and Jacobinism is on a par with Locke's declaration that it has been his "ill luck never to find a science founded on axioms;" and that the laws of Identity, Contradiction, and Excluded Middle are like the utterances, if he could speak, of "a monkey shifting his oyster from one hand to the other, and saying oyster in right hand is subject, and oyster in left hand is predicate." Equally absurd is the criticism that Bacon's method was not his own, because it was latent in his age. So, no doubt, the law of gravity was latent in the age of Newton, and the steam-engine in the age of Watt. We have seen that previous

thinkers had anticipated many of the principles of a physical method: it is a truism that every man is, to some extent, the child of his age; but the characteristic of originality is to be the first-born in the new thought. "The point," as Mr Lewes has remarked, "is to find a man dwelling on the necessity of a graduated Induction through successive steps of generality at a time when men had just begun to perceive that they must begin from experience in some way or other." Bacon was the first loudly to proclaim, if not the first to perceive, that "the regularity of nature's laws marked them out as objects of precise and certain knowledge." The discoveries of the latter half of the fifteenth and the whole of the sixteenth century had given the motive to more systematic investigation. Bacon indicated, in some measure correctly, the path it had to pursue, especially in his protest against "notions scarcely beneath the surface," and his dwelling on what he calls "middle axioms," as in reality the most important practical guides; and his treatment at the hands of many recent critics only goes to confirm one of his own assertions, that "great discoveries appear simple when they are made."

Still more fallacious is the contention that, in his analysis of the Inductive method, Bacon had been forestalled by the Greeks. We might as well assert that Newton was anticipated by the ancients because they observed the phenomena of "attraction" and used the word. Induction, ἐπαγώγη, is mentioned in connection with Socrates; but with him it meant simply a process of drawing on the mind to convictions about morals, by interrogations, and the use of Example and Analogy.

It made no claim to logical accuracy. Plato's Dialectic is a more elaborate process of rising from particulars to generals. In the 'Philebus' we are told: "The best way of arriving at Truth is not hard to point, but very hard to follow. The philosophers of the present day seize upon the One at hazard too soon or too late, and then snatch at the Infinite; but the intermediate steps escape them." Here and elsewhere in the 'Dialogues,' we have an idea of a series of subordinations, and the notion of unity as an end, which seems at first sight Baconian; but Plato's process is from thought to higher thought, not from observation to law. He moves in another world, and either slights what we call "Nature," or interprets it, as in the 'Timæus,' through Pythagorean fantasies. The *summa genera* of his search are the paradigms set forth in the 'Parmenides,' which he fails to tell us how to attain. The 'Theætetus,' after refuting the view that knowledge is mere sensation, starts the question what is true and what is false opinion; and the 'Sophist' can only answer that "not-being is difference."

With Aristotle, Induction appears as a logical form: he defines it as a peculiar kind of syllogism—"*τὸ διὰ τοῦ ἑτέρου θάτερον ἄκρον τῷ μέσῳ συλλογίσασθαι*"—by which, instead of the minor being connected with the major through the middle, the middle is connected with the major through the minor,—a statement easily made clear by a slight diagram, premising that by the major is here meant the most and the minor the least general notion:—



Aristotle's Induction is here a mere summary, reasserting of the whole that which had previously been ascertained of *all* the parts. Its conclusion does not go one inch beyond the premisses: it is a mental analysis, and may be brought under the ordinary rules of the syllogism by the expedient of quantifying the predicate, which makes it possible to draw a universal affirmative, A, in the third figure, as thus—

Isosceles, scalene, and equilateral triangles have their angles equal to two right angles.

Isosceles, scalene, and equilateral triangles are all triangles.

∴ All triangles have their angles, &c.

That Aristotle not only practised, but recognised, real Induction, is plain, especially from a passage ('Post. An.,' ii. 23) where, writing περὶ τῆς ἐπαγωγῆς, he says, "We find some animals with little bile live long, as man, the horse, the mule, and infer that all do." But for this he lays down no rules: he does not try to find any link of cause and effect between the phenomena, and is satisfied ('Post. An.,' i. 34) to refer to ἀγχίνοια, or the sagacity of happy guessing, in connection with observation detached from experiment. Bacon's Induction deals with facts so as to elicit a law out of them: it is a process of discovery, and cannot be reduced to syllogistic form, save by the notorious *petitio principii* of Whately's major, "These instances may stand for all instances." Bacon's ideal method, on the other hand, being in a sense geometrical, would give to the old inductive syllogism an immense, and in point of fact impossible, extension,—as thus:

The heat in *a b c* is an expansive motion.
The heat in *a b c* is *all* heat.
∴ *All* heat is an expansive motion.

It is this extension he has in view when he declares ('Nov. Org.,' B. i. 6), it would be an unsound fancy to expect that things which have never yet been done can be done except by means which have never yet been tried, when he says that he is "in hâc re plane protopirus et vestigia nullius sequutus;" and when he proposes to analyse Invention, as Aristotle analysed Propositions, and as the Greeks in general Reflection. But his claim to originality is largely valid, even as regards his accomplished work. It rests not least on his 'Redargutio' —more sustained and complete, as well as more persuasive, than any which had gone before—of the old wrong methods of physical reasoning, the old weary round of *a priori* deductions, the dry dogmatism and card-house system-building of the middle age, and the isolated empiricism of more recent times. No criticism has shaken his position, that it is only when we pass by well-defined steps fom observing phenomena to apprehending laws that theory becomes practical, contemplation operative, and knowledge productive. It remains true that when, by aid of the understanding duly restrained, inventive art produces the useful, and æsthetic art the beautiful, "Scientia humana atque potestas in idem concidunt." If Bacon's method is a mere restatement of common practice, or a revival of anything that had gone before, he not only exaggerates but wholly misconceives his work; for he is perpetually emphasising the difference, and insisting that his Induction is distinguished as experience from formal logic, and as logic from the experience of

daily life. Possessed, beyond any of his predecessors, with the idea of the progressiveness of knowlege, he feels himself removed *toto cœlo* from those who thought that all, or nearly all, things were already known—*πάντα γὰρ σχεδόν εὕρηται*. He constantly brings his own aims and ideas into direct contrast with those before prevalent, and, in the spirit of a confident iconoclast, endeavours to substitute the one for the other.[1]

But even in his own mind the substitution was incomplete, for he had set before himself, as the end of his research, an idea which, being half physical and half metaphysical, recalls the confusion of the Schools. His method, however it may err on one side by defect, on another by presumption, was in many of its features modern, but its aim was neither modern nor ancient. It was, indeed, something never attempted before, but it was also something which will never be attempted again. Recent Induction—that of Mill and Whewell, Herschel, Faraday, and Darwin—is the means by which the great sequences of nature, called laws, are investigated by the aid of apt conjecture, and by careful verification established. But Bacon thought to accomplish more than this. By aid of a method, which, from its exhaustiveness, he held to be as certain in its results as a demonstration of Euclid, "necessario concludit"; so mechanical that when once understood all men might employ it; yet so startling that it was to be as a new sun to the borrowed beams of stars; he aspired to penetrate into the inner nature of things, and so hold them in command. "In idem concidunt" means that knowledge of the cause will always enable

[1] Kuno Fischer's list of those oppositions is interesting.

us to reproduce the effect; and given the basis ('Novum Organum,' ii. 1) in a concrete body[1] (*vide* 'Novum Organum,' ii. 5), we can impose upon it the qualities which are the main objects of his clue.

Accepting the old maxim, "vere scire est per causas scire," which is true when translated "all philosophy is an inquiry after causes," and their traditionary fourfold division, Bacon assigns them as follows to his sciences:—

METAPHYSIC is the science of *Final* and *Formal Causes*, and results in SCIENTIFIC MAGIC.

PHYSIC is the science of *Efficient* and *Material Causes*, and results in MECHANIC.

Many of Bacon's arguments in the 'De Augmentis' and the 'Organum' are employed to expel from physics the inquiry after Final Causes prominent in the works of Aristotle and the Schoolmen: "Causarum finalium inquisitio tanquam virgo Deo consecrata non parit opera." He makes the too sweeping assertion that in the domain of nature the inquiry is barren: we want to know not *why* a thing is, but *what* it is. Final causes are "ex naturâ hominis potius quam universi," and must be discarded by the natural philosopher. Efficient and Material causes, on the other hand, belong properly to Physics, but they are "res perfunctoriæ" superficial: the former will only ('Novum Organum,' ii. 3), under certain circumstances, produce the required result; they cannot lead us to the root of knowledge, or enable us to grasp the natures of things. Our science is content to find efficient causes, and despairs of grasping the natures of things; but Bacon makes the latter the prime objects

[1] What conception Bacon had of this concrete body, without the "natures" he designed to impose upon it, it is impossible to say.

of his pursuit under the title of "FORMS," related to permanent qualities as efficient causes are to changes or events: when present, they will always be accompanied by the nature we are examining as *interpretes;* being found, they will always result in the production of the nature we desire as *ministri* ('Novum Organum,' ii. 4). The difficulty of apprehending this conception is increased by the variously inconsistent terms in which it is set before us. Sometimes Bacon insists that it is simple, as when ('De Aug.,' iv. 3) he says, "Men ought to have sunk their speculations for a while, and inquired what that is which is common to all lucid bodies; in other words, into the Form of Light, which will explain at once the light of the sun, rotten wood, scales of fish, &c." Elsewhere he talks of Form as if it were a mystery of faith which men are slow to believe, "they have a received and inveterate opinion that essential Forms or true differences of things cannot by any diligence be found out:" and he himself seems to approach the subject with a sort of awe, as Plato in the 'Republic' approaches the Idea of Good. As regards the name, he tells us, in the 'Advancement of Learning,'—"It seemeth best to keep way with antiquity *usque ad aras*, and therefore to retain the ancient terms, though I sometimes alter the uses;" but, perceiving that the old names may bring back with them the old conceptions, he is careful to tell us, to some extent at least, what he did not mean.

1. The *form* we are seeking after is not, of course, the outward shape, which is a mere matter of sight and touch.

2. It is not the *Pars formalis* of the Schoolmen,

whose supra-sensible forms (resulting from their confused jumble of Plato and Aristotle) he repudiates, calling them mere "commenta" or fictions.

3. It is not the Platonic ἰδέα, or any abstraction separable from concrete realities.

4. It is not a Law of Nature as now understood; for laws of nature are simply registers of general or universal truths inductively ascertained.

5. It approaches nearer to the Aristotelian εἶδος, but is not identical with it, because it has more to do with physical investigation.

Bacon's doctrine of Form, being a mode of explaining phenomenal by a noumenal and yet physical world, it has to be observed that he nowhere openly grapples with the question of the relation of substance to attribute, which has been the battle-ground of so much later metaphysics. He very vaguely,[1] if at all, admits the existence of any οὐσία, ὕλη, ὑποκείμενον, or "noumenon" as a substratum of qualities. For all he says to the contrary, *substances* may simply be the *unions of qualities*, and in his so-called materialism we may find the germ of the idealism of Berkeley. So much is plain, that Bacon regards every complex body as a *turma* or congeries of "natures," which it is the object of his higher logic to discover and analyse, the analysis being a statement of their Forms—*i.e.*, the resolution of them into simpler, better known natures, determined by a differentia to act or exist in a certain way. As aids in the process, he sets before us two subordinate conceptions, which make, as it were, the bridge from his

[1] The nearest approach to it being the data basis of 'Novum Organum,' ii. 1, above referred to.

physic to his metaphysic—conceptions to which recent science has given increased validity. These are—

1. *The Latent Schematism*, or invisible and hence latent structure of bodies, on which many of their qualities depend ('De Augmentis,' ii. 1, 'Novum Organum,' ii. 2 and 48), as the structure of crystals displayed by cleavage, and the disposition of their various properties, as density, rarity, weight, &c.

2. *The Latent Process*, having the same relation to bodies molecularly in motion as the Schematism has to bodies (if such there be) molecularly at rest. It is the secret process by which changes are brought about, as the process which takes place in the cannon between the application of the match and the expulsion of the ball, or in a seed before the sprout is shown. Bacon accepting as an axiom the law of continuity in nature, holds that we may infer the succession of unseen changes from those which are seen: but this, he says, is hard to do; it is the work "not of fire only, but of the finer analysis of the mind." Both conceptions have, since he wrote, received illustrations in the more and more penetrating investigations of Physiology and Botany that, under the guidance of Cuvier and Bichat, Schleiden and Schwann, Spallanzani and Virchow and Bernard, have gone from organ to tissue, and from tissue to cell and protoplasm.

In a noteworthy passage of the 'De Augmentis,' repeated from the 'Advancement of Learning' (iii. 4), it is made plain that the doctrine of Form is not designed for complex bodies.

"The forms of substances . . . are so perplexed that they are not to be inquired: no more than it were possible . . . to seek in gross the forms of those sounds that make words,

which by composition of letters are infinite. But, on the other hand, to inquire the form of those sounds or voices which make simple letters is easily comprehensible. . . . In like manner, to inquire the form of a lion, of an oak, of gold—nay, of water, of air—is a vain pursuit; but to inquire the forms of sense, of voluntary motion, of vegetation, of colours, of gravity and levity, of density, of tenuity, of heat and cold, and all other natures and qualities which, like an alphabet, are not many, and of which the essences, upheld by matter, of all creatures do consist—to inquire the true forms of these is that part of metaphysic we now define."

It is clear, then, that Forms relate to Qualities. Bacon has nowhere drawn a definite line between those which are Primary[1] and those which are, in our nomenclature, Secondary; but his distinction between the Essential, which he seems to regard as causes of the Non-essential, is an approach to the division; and the question arises, with which class is Form concerned? The inquiry is complicated by Bacon's own confusing and sometimes inconsistent imagery. In 'Novum Organum,' ii. 2, he speaks of Form as a Law. Nothing, he says (in opposition, as has been pointed out, to the old Realism), actually exists but "*corpora individua, edentia actus* (an assertion of the activity of substance), *puros* (*i.e.*, ἐντελέχειαι, not mere κινήσεις), *individuos* (meaning that the analysis of the thing into simple natures is con-

[1] It has been observed that "Primary Qualities" are, like Bacon's Forms, more or less ideal. Locke defined them as "such that are inseparable from the body in whatever state we find it, giving as instances, Solidity, Extension, Figure, Motion or Rest, and Number;" while Brown gives Solidity, Extension, and Resistance. Neither has clearly shown how we can derive from them the Secondary Qualities, as Colour, &c.

ceptual, not real) *ex lege*," which is the Form.[1] Elsewhere he calls it, with an echo of the Arabic Aristotelians, "fons emanationis," that from which the thing flows; again, it is "res ipsissima."[2] In another passage it is "vera differentia";[2] again, it is the "natura naturans"—a phrase used by some of the scholiasts, by Bruno, and afterwards by Spinoza—and the "causa immanens." It is "interius" and "existens," as opposed to "exterius" and "apparens," — the hidden nature elicited from the concrete manifestation, the spring of the unseen operations of the latent process of bodies in motion, or the ground of the configuration of bodies at rest. A clearer view is presented in the definition ('Novum Organum,' ii. 1), "*Natura alia quæ sit cum naturâ datâ convertibilis et tamen sit limitatio naturæ notioris*," elsewhere called "*magis communis*." Bacon seems to mean that the elements of complex bodies may in their turn be further resolved. The form nature and the phenomenal nature are present always in a fixed proportion: we have to reach the one through the other, breaking down the less known species into a better known genus and difference. Thus, *Heat* is re-

[1] The interjected comments are slightly condensed from those of Mr Ellis, who makes the remark about Realism: but elsewhere the same critic observes that, in reference to another aspect of his Forms, Bacon was himself inconsistently "led astray by a sort of Realism, which held that the objects of our thoughts may be regarded as an assemblage of abstract conceptions (*notiones*) really residing in the objects as essential qualities, whereas we can never analyse or exhaust the forms they may assume."

[2] Those two expressions are not logically reconcilable, as "the very thing" is the genus + the differentia; but Bacon dwells on the latter as the more important.

solved into *Motion*[1] (*magis communis*) + *a kind of expansion;* whiteness into the mixture of transparent bodies + a special arrangement of their particles. This analysis, in his belief, not only adds to our knowledge but to our power; for, although nature is herself the agent and plays her own cards, we can shuffle them so as to determine the result. Arrangement with Bacon is, as with Pythagoras, almost everything; and it is in our power, when we have availed ourselves of the key, to manipulate the internal structures of things, as in "a sort of microscopic building." When the map is drawn, we may thus reduce all the phenomena of the universe to combinations of simple natures, which we may recombine and superinduce on various substances,—as the alchemists thought we could reduce all the elements to one, and so transmute them through their common basis. It may help to make this notion, which cannot from its vagueness be made clear, a little more comprehensible, if we compare Bacon's mode of treating a physical problem with that of the ancient schools and of modern science. Let the question be, What is gold?

1. Plato, though in the later Dialogues he dwelt more on larger and mainly moral themes, might have answered: There is an Idea of gold in the divine mind, of which

[1] In the passage quoted from 'De Augmentis,' iii. 4, Bacon mentions "voluntary motion" as a thing of which we may find the form, but elsewhere speaks as if motion were one of those "simple natures," into combinations of which he held all the phenomena of the universe might be reduced. We can attach no meaning to the form of a "simple nature," which is by definition irresolvable. "Form" can only be understood as the differentia of a simple nature (which is the genus), or as the simple nature itself, *plus* the differentia; but the decision is perplexed by Bacon's confused classification of qualities and relations.

all special golds are copies: the human mind partially participates in this Idea, and by a process of contemplation may attain to realise it.

2. Aristotle would have answered: There are varieties of gold, but there is something common to all by which we recognise them as such; the τό τι ἦν εἶναι — that which makes each to be so—which, withdrawn, we can no longer concede it to be gold. By comparing the kinds and rejecting everything peculiar to each, that common to all—the logical definition, the metaphysical εἶδος—remains as the result of a mental analysis.

3. A chemist would take the gold into his laboratory, subject it to a physical analysis, and find that it had certain properties—*i.e.*, was subject to certain laws, and made up of certain elements which he could decompose no further, and which he might be able to put together again or not, according to circumstances.

4. Bacon, by a process of analysis, half mental half physical, discovers that the Turma or congeries known as gold has a certain Schematism—a way in which its "natures," density, softness, colour, &c., are arranged. Find that Schematism and the Forms of these natures, and we may make gold. For, he says in the 'Sylva Sylvarum,' after enumerating the qualities, "if a man can make a metal that has all these properties, dispute whether it be gold or no." But Bacon necessarily failed to find his simple natures: and as, when failing in his search for simple notions, he fell back on the hope of other Inductive processes, so now, finding it impossible to demonstrate his process, he left it incomplete, betook himself to concrete examples in Natural History—

"Atque opere in medio defixa reliquit aratra."

CHAPTER IV.

NATURAL HISTORIES, 'SYLVA SYLVARUM,' AND 'DE PRINCIPIIS.'

Bacon became conscious that the task he had set himself was incapable of completion. His sands were running; the aid of other men, "at home or beyond seas," in the progress of his work, had failed him; and he turned from what was at the outset his chief design,[1] the perfection of a new logical machinery, to the accumulation of the material on the fulness of which he now felt discovery must rely. In the 'Distributio Operis,' he still writes as if he hoped to see Part III. of the 'Instauratio' brought near to a close,—'Tertia Pars complectitur Phenomena Universi,'—and even Part IV. fairly advanced; but, in the General Preface, he admits that it is beyond the compass of a life; and this belief grew on him. During his later years, with restricted means, the limits set to his achievement were narrowed; and, in

[1] Mr Ellis's view is supported by the fact that Bacon, in his earlier works, as the 'Valerius Terminus,' makes hardly any reference to the 'History,' and dwells, almost exclusively, on the 'Interpretation of Nature,' as the centre of his system. Mr Spedding, however, claims that place for a complete classified natural history; and, in a curious dialogue affixed to the 'Parasceve,' argues as if he believed it capable of accomplishment.

the introduction to the 'Natural History' (1622), dedicated to Prince Charles, while giving still greater prominence to the subject, as "the key of all knowledge and operation," he speaks more despondently[1] of the completion of the work he had once held might be accomplished in a few years (as Aristotle's 'History of Animals,' by aid of Alexander): now he can only hope to see started a process of investigation, where one set of persons may collect and another interpret. In the same paper he shows himself more aware of the impossibility of fully demonstrating his Inductive progress, or attaining, by any short cut, the conceptions he admitted to be indispensable; and we find him, in the special introduction to the 'Organum,' and later in the preface to the 'Prodromi,' attaching more weight to the ordinary methods. He desires to implement, not to destroy, and admits there may be "two streams and dispensations of knowledge," as there are two tribes of students: those without the gates, content to adorn our present possessions; and the true sons of science, who aspire to overcome nature by invention. In the 'Parasceve' he emphasises the importance of facts and their utility in themselves, even though they may not lead us to the ultimate laws imaged in the 'De Augmentis' as the apex of the pyramid: elsewhere he refers to experiments and observations as not only supplying Part III., but being no mean preparation for the types of the 'Scala Intellectus.' Nothing is more characteristic of the unconquerable elasticity that makes

[1] Later still he confesses to Fulgentius that it will require the research of ages, but holds that, soon or late, it will be a κτῆμα εἰς ἀεί, the possession of a Promised Land.

Bacon the Antæus, alike of politics and philosophy; nothing is more marvellous than the tenacious confidence with which, in the overture to the 'Historia Naturalis,' he ignores his failures, and magnifies the remains of his partially frustrated design. No passage of his eloquence approaches more near in tone to that of the Liturgy than these closing paragraphs, after reference to the false lights of fancy and the chains of custom :—

"The constellation of Lyra rises by edict, and authority is taken for truth, not truth for authority. . . . We copy the sin of our first parents while we suffer for it. They wished to be like God, but their posterity wish to be even greater. For we create worlds, we direct and domineer over nature, we will have it that all things *are* as in our folly we think they should be, not as seems fittest to the divine wisdom, or as they are in fact. . . . If, therefore, there be any humility towards the Creator, any reverence for or disposition to magnify His works, any charity for man and anxiety to relieve his sorrows and necessities, any love of truth in nature, any hatred of darkness, any desire for the purification of the understanding,—we must entreat men again and again to discard, or at least set apart for a while, these volatile and preposterous philosophies, which have preferred theses to hypotheses, led experience captive, and triumphed over the works of God : and to approach with humility and veneration to unroll the volume of creation, to linger and meditate therein, and with minds washed clean from opinions to study it in purity and integrity. For this is that sound and language which 'went forth into all lands,' and did not incur the confusion of Babel: this should men study to be perfect in ; and, becoming again as little children, condescend to take the alphabet of it into their hands, and spare no pains to search and unravel the interpretation thereof, but pursue it strenuously and persevere even unto death."

"Magna ausus:" Bacon almost invariably disappoints us in dealing with the particulars to which he has given introductions so imposing. Defeated in his search for simple "natures," he was thrown back on the fruitful field of special phenomena. That he failed to reap more than a few sheaves from its abundant harvest was due in part to "the vaulting ambition" belonging to himself and to his time. None of the leading Elizabethans had learnt to limit their aspirations: all fountains of perennial interest, no one of the group will ever be regarded as an authority—Bacon, in some respects, least of all. He had undertaken a task for which he was constitutionally unfit. Politicians still find in his papers of State traces of almost prophetic power: he is the European master of prudential morality; in the 'De Augmentis' we have a manual of private and public diplomacy lit up by gleams of loftier views: modern logicians move, in some degree, in the track of his method; but no physicist turns his pages for a single fact.[1] His anticipations are, like those of the 'Fairy

[1] It is, nevertheless, generally admitted that Bacon has some claims to a place among physicists. His idea of *Heat* as an undulatory motion—especially the passage in the 'Novum Organum beginning, "The third specific difference"—has enlisted the approval of Tyndall; his refutation of the fancy of Caloric by an appeal to friction has been accepted; also his view of colours, as the manner in which bodies, in virtue of different textures, reflect different rays. Sir John Herschel admits that some of the prerogative instances of the 'Novum Organum' might have given Newton suggestions as to the discovery of the composition of *Light*. Bacon's experiments with his rude thermometer ('Novum Organum,' ii. 13, &c.) on the compressibility and density of water and the weight of air have been generally commended, as his guesses ('Novum Organum,' ii. 35, 36-45) at the facts of attraction and repulsion according to distance. Humboldt compliments his view of the connection of wind with

Queen' about the stars, flights of an imagination almost as unique in prose as Shakespeare's in verse, sustained by the conviction that there are more things "than are dreamed of in our philosophy." But, with a synthetic power rarely rivalled, Bacon was an indifferent analyst; his care was not to "part and prove," but to announce and harmonise. As a lawyer, he had little reputation for the examination of his witnesses; as a man of science he has less. He lacks the sense of proportion, which gives their respective places to things small and great: hence his lists — as of the one hundred and thirty desiderated histories appended to the 'Parasceve'; that which accompanys his 'Abecedarium' or system of notation; that of proposed inquiries in the 'Commentarius Solutus,' or of the "Magnalia Naturæ" at the close of the 'New Atlantis'—are confused and confusing heaps of suggestions, bound together by no principle save a common theme or name. He was hampered by his own "Idola Fori," partly because he had not shaken himself free from the dominion of those very notions which he was combating with all the resources of his eloquence. It was inevitable

climate, and credits him with being the first to state the law of rotation in winds; while Geoffroi St Hilaire, in a paper on artificial incubation (1816), speaks with approval of the experiments suggested in the 'New Atlantis.' The constant reference in the same work to the wonders to be revealed by the microscope have received no more than due notice. The same may be said of Bacon's forecasts about the time required for the passage to the earth of the light of stars; his suggestions of telephones, balloons, submarine boats, new explosives; the cures of disease and mitigation of pain by some equivalent for chloroform; of his acute guesses as to the formation of strata, the succession of species (*vide* 'Novum Organum,' i. 66), his constant groping after the law of gravitation, and his idea of the union of formal and physical Astronomy.

to his position on the verge of two ages, that while consciously pressing toward the future he was unconsciously influenced by the past. His Physics and Psychology recall the first guesses of Thales and Diogenes of Apollonia. His conception of the "Anima" and "Spiraculum," the assertion that all bodies are animated, that they abhor a solution of continuity, that cream rises to the surface from the desire of homogeneous elements for each other, that there is a tendency on the earth's surface for some things to go up and others down, and, among the spheres, "affection" for a forward or a backward course, with many of the professedly universal axioms of the receptacle of theses to which he gives the name of "Prime Philosophy," belong rather to the late-born heir of Democritus, or the successor of Paracelsus, than to the forerunner of Newton.

In Bacon, the Indian myth about the strength of the dead warrior passing into his conqueror often seems reversed; for he inherited the mental diseases of those he imagines himself to have slain. His mode of dividing nature is more that of Aristotle than of Galileo. In the act of arraigning the former he is nowhere more Aristotelian than when he speaks of heat and cold, dense and rare, light and heavy, natures and appetites, as if they were absolute qualities, instead of terms as relative as up and down, broad and narrow, straight and crooked. Similarly, he separates things akin, unites things different, and rushes without counting his steps to the "maxime generalia" he deprecates. Apart from preconceptions, he had, on his own last chosen field, none of the practical talent or tact of the experimentalist, which, by

a combination of manual skill and selective intuition, has often led those with a tithe of his genius to great results. We need not, therefore, be surprised that Bacon's discoveries had been, as far as they were true, for the most part anticipated; that he even receded from many positions previously held; or that the record of his definite mistakes is greater than that of his achievements. From Aristotle downwards he misconceives or misrepresents the majority of his predecessors. In Geometry he ignores almost all that had been done from the time of Euclid to that of Vieta. Complaining, in 1623, of the want of new methods of calculation, he says nothing of Napier's Logarithms, published in 1614. In Mechanics he takes no note of Archimedes (whose solution of the problem of the crown he failed to understand), Ghetaldus, and Galileo, referring to the last only as an observer of the moon and stars. He proposes an inquiry about the lever without realising its theory, and an experiment on windmills futile from neglect of an essential point. In Astronomy he seems to have been ignorant of the researches of Tycho Brahe, never to have heard of Kepler, and his rejection of the theory of Copernicus increases in dogmatism. In the 'De Fluxu et Refluxu Maris' he doubts the rotation of the earth; in the 'Thema Cœli' he inclines to its fixity; in the 'De Augmentis' he refers to the opposite view as "falsissimum." He speaks of the poles of the earth, unaware of the precession of the equinoxes; and of the north as *above*, the south *below*, to explain the cold winds in our latitude. He depreciates Roger Bacon, who invented gunpowder, whereas Francis thought the courage of soldiers might be increased by eating it; and does not

recognise Harvey, whose discovery of the circulation of the blood—achieved by the use of the argument from final causes denounced in the 'De Augmentis'—was made known in 1619. His mistakes about heat partially excuse the modern ignoring of his true intuition as to its nature. His "Tables," suggested in 1608, make no reference to Galileo's thermometer, designed in 1597, and made known in England in 1603. Asserting that the moon's rays give no warmth, he believes that the conjunction of any two of the three highest planets is among the causes of excessive heat. He maintains that heated iron does not expand in bulk, and that delated[1] air does not increase in heat. Bacon, often a victim to the practical credulity which constantly appears as the mocking shadow of scepticism, is as ready to accept marvels as Mandeville was to invent them. He admits all the popular views as to the influence of the moon on the weather, and the rising of Orion bringing storms. He believes that ordnance had been known in China for two thousand years; that ashes remain undisturbed on "the windless summits" of Mounts Athos and Olympus; that the Andes are the highest of mountains, because everything in America is bigger than in Europe; that the bloodstone is a preventive of bleeding at the nose; and that the heart of an ape, worn near the heart of a man, increases audacity.

It is this sort of illegitimate "permissio intellectus"

[1] 'Novum Organum,' ii., Aph. 18. Yet almost in the next page, Aph. 20, he says that air manifestly expands with heat. There is the same inconsistency in his views as regards a vacuum: *e.g.*, 'Novum Organum,' Aph. 8, and 'Hist. Densi et Rari,' he pronounces against it; while in 'Novum Organum,' Aph. 28, and the 'De Principiis,' he speaks of it as an open question.

—this blending of almost childish acquiescence and almost superhuman daring, ranging from the reception of discredited superstitions to "things unattempted yet in prose or rhyme"—that is so distasteful to most modern leaders of exact though limited research; who feel that no stretch of imagination can suddenly "storm the citadels" of Nature, and that the favourite maxim, "Possunt quia posse videntur," may be pressed till it become an empty boast. It is this neglect of the other maxim, "Figere contemplationes et morari et hærere in omni subtilitate differentiarum," that withheld Bacon—whose overstretched analogies over-played the part of the hypotheses he discarded—from a single definite discovery; that would make it a waste of time for competent specialists even to examine or discuss the value of his fragmentary contributions to the progress of Natural Science. Of these, the 'History of the Winds,' the first published part of the 'Natural History,' is introduced by an "aditus," or overture, again inspired by a breeze of the west. "Venti humanæ genti alas adderunt. To men the winds are as wings, for by them they are borne and fly—not indeed through the air, but over the sea, . . . and the whole world is made open to them. To the earth they serve for brooms, sweeping and cleaning both it and the air. Yet they do violence to the nature of the ocean, which would otherwise rest in harmless calm." There follows a list of thirty-three possible and impossible inquiries, ending with the remark expressive of a thought growing more and more familiar to his mind, "Posteri cætera videant." The body of the book, compiled from Aristotle's 'Problems,' Pliny's 'Natural History,' and Acosta's 'History of the Indies,' with references

to Virgil, Paracelsus, and Gilbert,[1] is a mass of facts and inferences thrown together under heads not always logically arranged, but redeemed from dulness by suggestive metaphor and description—as in the account of an English man-of-war of the time. At the beginning of the seventeenth century little progress could be expected in the department of Meteorology, scarcely even now become a science, though the phenomena with which it is concerned have been in all ages among the first to attract attention.

Of somewhat the same nature is the earlier treatise on the TIDES. This subject, of little interest to the nations of antiquity, whose navigation was mainly confined to the Mediterranean, naturally came into prominence with the extension of maritime discovery, and during the sixteenth century called forth the research and stimulated the ingenuity of Cesalpinus, Patricius, Acosta, Otto Casmann, and Chrysogonus, without, however, even in the hands of Galileo himself, leading to a true solution. Bacon—who, in the 'Novum Organum,' rejects the theory of the last-named on the ground of its involving the earth's motion, and that of Telesio to the effect that the sea boiled over when heated by the sun, moon, and stars—on more solid grounds has, in this tract, suggested many reasonable considerations; and, by an induction as far as it goes correct, arrived at the conclusion that the tidal wave is progressive, not on remote shores simultaneous. He is also entitled to the credit of being the first to point out the necessity of assuming

[1] Bacon must have seen his 'Physiologia Nova,' which, though not actually published till 1643, is known to have been circulated in 1612.

a derivative tide. But his ideas of undulation are necessarily vague; and, after touching on the influence of the moon, he reverts to the supposed diurnal motion of the planets and to the data of an imperfect geographical knowledge. Similarly the treatises 'De Luce et Lumine' and 'Historia Soni et Auditus' are expressions of antiquated views of Optics and Acoustics, supported by a limited range of observation and experiment. The 'De Magnete' is a mere page of disjointed statements, singularly meagre if written after the appearance of Gilbert's work in 1600. In the 'Calor et Frigus' and 'Historia Densi et Rari,' Bacon's inaccuracies are of less moment than the fundamental confusion which the titles themselves display.

The systematic and successive development of most of the physical sciences belongs to a later age: Bacon's great reproach in this department is his distinctly retrograde Astronomy. In the 'Descriptio Globi Intellectualis' and 'Thema Cœli,' we perceive in every page the influence of ideas as obsolete as those of the 'Timæus,' modified by the anxiety to be a "novelist," and, at all hazards, to contradict his predecessors. Nowhere is Bacon's jealousy of Hypotheses and subordination of Mathematics so injurious as in his treatment of a Science, where the distinction between the real and the apparent is all-important; where experiment, in the ordinary sense, is impossible; where the advances, even then so considerable, which had been made in the past, resulted from the application of theories to observations; and where even inappropriate hypotheses (according to the Baconian rule, "citius emergit veritas ex errore quam ex confusi-

one") had been the essential precursors of others more and more nearly true. Bacon's method, rigidly applied, would have foreclosed the earliest discoveries of the Greeks, in a sphere where the evidence of sight is incapable of correction by the other senses. According to his way of working, it has been observed, not even the identity of Hesperus and Lucifer could have been determined. Here again he is, however, inconsistent with himself; for, after rightly protesting against the postulate of circular motion, he brings in two hypotheses of his own, resting on a basis no more firm than those he scornfully dismissed,—*i.e.*, that the courses of the planets must be explained by motion in the same direction with different velocities—a view derived from Lucretius through Telesio — and the postulate that they move in spirals, without attempting to determine more definitely the nature of the curves. His other assertions—as that the spirals are quicker and approach nearer to circles as we recede from the earth, which is the centre of rest; that the farther atmosphere becomes more rare, till, in the region of the moon, flame can support itself, and in that of Jupiter and Saturn it begins to be dispersed and extinguished—are no advance on the fancies of Anaximander.

In the 'Historia Vitæ et Mortis' (published separately in 1623, in preference, by reason of its greater importance, to the postponed treatises on Salt, Mercury, Sulphur, &c., of which we have only the "aditus"), Bacon, treading on more human ground, discusses at greater length the theme of the Fourth Book of the 'De Augmentis.' This volume is remarkable for the prominence given to the means for the

prolongation of life (among the duties of a physician, *omnium nobilissima*), taking for granted that the causes of the duration of existence and of health are the same. Much of the treatise is occupied with examples, variously substantiated, of long life, in which the author draws on his sources,—Pliny, Valerius Maximus, the 'Res Memorandæ' of Petrarch, with similar collections of Fulgosius and Egnatius, the 'Theatrum Vitæ Humanæ' of Zwingler (the only German, save Paracelsus, anywhere quoted in his works), and the 'De Mirabili Potestate Artis et Naturæ' of Roger Bacon,[1] —with his usual want of discrimination. The theory of the work, in which, as elsewhere, we have a congeries of intuitions since proved correct, and such popular errors as those afterwards narrated by Sir Thomas Browne, relies on the author's psychology. There are, he says, two kinds of spirits: 1. Crude and mortuary, present in inorganic bodies, and "only seen in operations"—an extension of the idea of life derived from Paracelsus, and the prevalent belief in the virtues of crystals, &c., that appears in Lilly's 'Euphues' and other representative transcripts of the beliefs of the age. 2. Vital: the cause of the phenomena of life that tends to slip from the body or to burn it,—(*a*) by drying up moisture; (*b*) by flying through the pores; (*c*) by contracting denser parts. The main object of physicians should be to resist these processes, by means detailed in a long series of directions and prescriptions, and so "to

[1] This tract was published in English in 1618, and Bacon's reference to it is our only distinct evidence of any acquaintance with the works of his famous forerunner. Roger Bacon also wrote 'De Retardentibus Senectutis Accidentibus,' but this was only published in 1683.

keep the wine of life from oozing away." The chapter of most literary and general interest is that on "Youth and Age," which, in the account of the infirmities of the latter, is closely paralleled by Hamlet's satirical speech to Polonius, while the pathetic contrast of the whole suggests comparison with the verses of Coleridge on the same theme.

No other great writer has repeated himself so much or so often as Bacon has done. In the last three years of his life (1624-1626), he gathered up in the 'Sylva Sylvarum'[1] an accumulation of facts, beliefs, fables, and conjectures ranging over all the fields of nature. Rawley's preface to this work, written during Bacon's life and presumably with his sanction, informs us that his lordship regarded it as payment of a debt, in lieu of the Third Part of the 'Instauratio'; that he felt restive under the necessity of devoting so much time to the accumulation of details, as if, "like the Israelites, he had to dig the clay, burn the brick, and gather the stubble for the fire;" that, whereas the natural histories extant, compiled for delight and use, are full of pleasant descriptions, his lordship intended one "such as might be fundamental to the illumination of the understanding and the extracting of axioms;" that, "as for the vulgarness of his instances, he held that true axioms must be

[1] Mr Ellis considers the title of this work to be a Hebraism, like "the love of love," "the wood amid the woods." Mr Spedding takes it to mean "a collection of collections." In the preface to the 'Scala Intellectus,' the tangled wood of nature is represented as leading us to the heights of discovery. We are informed by Rawley that the 'Sylva Sylvarum' was the mere beginning of an intended work on the 'Phænomena Universi,' which, Bacon says, in a letter to R. P. Baranzan, would be six times larger than Pliny's 'Natural History.'

drawn from plain experience, not from doubtful;" that "his course was to make wonders plain, not plain things wonderful;" that he added to his facts the suggestion of causes, lest men should think their minds lost in a wood of experience; and that he put together his particulars without much apparent method, "though he that looketh attentively into them shall find that they have a secret order." In adducing the thousand "prerogative instances and experiments, solitary or in concert, a hundred to each century," of which the book is composed—in gathering facts, conclusions, and conjectures from every clime and time of natural phenomena, Bacon laboured under the disadvantage of never having been, save in his youthful trip to France, himself a traveller. If he does not, like the German, construct a camel from his inner consciousness, he has to rely largely on second-hand information which he has not the critical acumen to test, and so receives, with rare protests and doubts, the records of his authorities, reading and skimming, rather than digesting, Aristotle's 'Problems' and 'Meteorologics,' Pliny's 'Natural History,' Porta's 'Natural Magic,' Cardan's 'De Subtilitate,' and 'Sandy's Travels'—the last of which he follows from book to book in their actual rather than their logical order, taking up the points of narrative as they came to his hand. The popularity of this book was (as pointed out by Mr Ellis) in large measure due to what, in our more sceptical and scrutinising age, would be deemed a fault—the author's ready acceptance of marvels. About these there was a greater curiosity than now, when the zeal for the discovery of causes and the love of explanation has

succeeded to the more primitive delight in wonder that pervaded the Elizabethan age, and lingered even in civilised centres, to the time when Dr Johnson was brought to London to be touched by Queen Anne for the cure of his scrofula.

The mystery of the secret order of the 'Sylva Sylvarum,' suggested by Rawley, remains unsolved; and it is more difficult than in the case of the 'De Augmentis' even to state the often interleaved subjects of the several "Centuries"; the adequate criticism of any one of their themes being, in our age of subdivision, employment enough for many specialists:—

I. The *First*, devoted to what Bacon calls "Percolation," or the passing of bodies through one another, contains many interesting suggestions as to the movements and classifications of liquids, with a view to their medical effects, their straining, condensation, mixing, infusions, &c. In the course of these examples, he gives us a clearer view of his conception of mortuary spirits; as the rarefaction of a natural body, enclosed in the tangible parts as in a cover, typified by the relation of Proserpine to Pluto. Nowhere do we find a closer approximation to the true conception of the law of gravity than when it is stated that it worketh more weakly as it recedes from the earth, "because the appetite of union with dense bodies is made more dull by distance;" and nowhere a more curious anticipation of the discoveries of heat than in the following: "We know the effects of Heat to be such as will scarce fall under the conceit of man, if the force of it be well kept together." The book concludes with a protest against the idea that anything can be annihilated except by Omnipotence, and a suggestion

that if we press Matter nigh to death, it will, like Proteus, reveal its essences, being unable to escape.

II. The *Second* is devoted to *Music*—its concords, discords, and harmonies, and the relation of terrestrial to celestial sounds. On this head it may be remarked that many of the views propounded have been received with acceptance by critics of our own day, as Charles Butler of Magdalen.

III. The *Third* is devoted to the motions of sounds generally. They move in all ways; but "linea recta brevissima." Then follow discussions on various problems,—repercussion of echoes, the construction of notes, the relation of the ear to sound, &c., leading up to suggestive hints for practice in the art of health—*e.g.*, as long life proceeds from the placid motion of the spirits, which then less prey on the body, do nothing "invitâ Minervâ," but everything "secundum genium."

IV. The *Fourth Book*, of "Instances and Trials," deals with the processes of art—*i.e.*, contrivances to accelerate or retard the ordinary working of Nature; under which head Bacon treats of the fermentation and preservation of vinous and malt liquors; the prevention, by cold and excluding the air, of putrefaction (of special interest as the suggestion of his last experiment), the means of hastening birth and growth; the relation of nourishment to life and health; the continuity of flame (including a reference to subterranean fires), and the transformation of metals, introducing some remarkable paragraphs on the making of gold. This work he judges to be possible; and, in entering into details, while repudiating the methods of the Alchemists, and referring the results to the work of long-continued heat (as in his

assertion that silver is more easy of manufacture from lead or quicksilver), he provokes a reference to the great satirical play of Ben Jonson, which had fifteen years previously — *i.e.*, in 1610 — been brought upon the boards. It is remarkable that, in his practical directions, Bacon makes no reference to his doctrine of Forms and superadded Natures, which comes in only as an appendix.

V., VI., and VII. These *Centuries* (though, at the close of the last, implemented by zoological and anatomical speculations more properly belonging to the section[1] which follows) are engaged with questions relating to the nature and management of Plants, to speculations on Agriculture and Horticulture. Amid much shrewd observation on the relations of climate, soil, and seed, on medicinal effects, on grafting, manuring, the exclusion or concentration of solar rays, &c., with curious references to exceptional growths — as mosses, mushrooms, and the mistletoe—the writer is often led away from his scientific purpose by his belief in sympathies and antipathies between the mineral, vegetable, and animal worlds. His 'Georgics of the Earth' are, however, entitled to the same praise as his 'Georgics of the Mind': they show the almost unparalleled range of his interests, and relate to a subject he had really studied—to which he had in his 'Essay on Gardens' given a more artistic form than is to be found in Evelyn's 'Silva'—and they have called forth the enthusiastic praise of modern botanists.

VIII. and IX. In the eighth and ninth divisions of

[1] The arbitrary division according to centuries is fatal to a really methodical arrangement of the work.

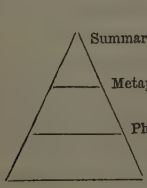
his universal *répertoire*, Bacon's want of method (exceeding that of Browne or Burton) amounts to disorder. We have the old views of heat and light and weight, of the influence of celestial rays, of growth and friction, the rise of water over flame, the want of rain in Egypt, the refining of metals, weather prognostics, the source of fevers, the nature of the teeth, the treatment of wounds, pestilences, drinks, and baths,—almost every fact and fancy of the then known psychology and physiology, side by side with new conjectures as to the possibility of men flying like birds, the source of appetites, sleep, spontaneous generation, &c. The most interesting sections are devoted to a discussion of the relations of the mental affections, as fear, grief, and pain, joy, anger, shame, dislike, disgust, pity, wonder, laughter, &c., to facial expressions, and bodily postures, which may have supplied hints to Lavater, whom many of those suggestions, often even in detail, forestall.

X. *The tenth Century* is devoted to the subject of the force of Imagination; the mysterious passages of thought from one human being to another; the harmony between psychical and physical influences, which in our day has claimed so much attention and brought into collision the extremes of credence and of scepticism. Against the latter Bacon records his protest, in warning us against the excessive incredulity which is a mark rather of inexperience than of critical power: but he has by no means "a bottomless maw" for marvels; and this book supplies as sound criteria for testing such phenomena as "willing," telegraphy, "second sight," animal magnetism, conjuring, &c., as even our nineteenth century has devised. The 'Sylva Sylvarum,' though a

jest-book for specialists, affords, on the whole, the best collection of experiments and observations up to the date of its publication.

Towards the close of his life we find Bacon working at the two ends, as it were, of his system.[1] He had laid what he himself regarded as its incomplete foundations in the 'Sylva Sylvarum.' In the 'De Principiis atque Originibus' (certainly, from its allusions, of later date than the 'Organum') we have a statement of his ultimate cosmological, if not metaphysical, views. The addition to the title of this interesting tract, 'Secundum Fabulas Cupidinis et Cœli,' shows that his mind was still in the groove of the earlier 'De Sapientiâ Veterum'; where he tries to find, and presents with all the adornments of his imagery and the super-subtleties of his interpretation, traces of philosophical truths shadowed under the veil of mythology. As far as Bacon had arrived at any definite cosmological conclusions, they were those of Democritus, who, most among the theorists of antiquity, is exempt from his censure and complimented by his praise. The Atomists, dissecting instead of abstracting, had, in his view, kept in touch with Nature: their views preceded as his own succeeded the

[1] The expression is justified by Bacon's own conception of knowledge as a pyramid, in 'De Aug.,' B. iv., which may be thus represented:—



centuries of pure speculation between. The question of their scepticism was hardly raised in his mind, and he contents himself with remarking that they pushed their Physics too far—a charge he also brings against Aristotle for his denying or ignoring a supreme First Cause. With them, he held that all Philosophy was included in the Natural Sciences. They, as well as he, tried to explain the secondary by the primary qualities of matter, and assumed the existence of matter and mind in all questions of knowledge. Too late for the method of the schools, too soon for that of Descartes, Bacon looked upon both sides of the argument regarding perception and sensation as "ingenious sophistry." He rejects the postulates of the Atomists as to a Vacuum and the unchangeableness of the Atoms, but he agrees with them in taking for granted our knowledge of external things, and referring their impressions on the sense to media. Finally, his Psychology is either empiric or Lucretian.

The fragmentary 'De Principiis,'—marred by the writer's ignorance of the fundamental position of the Eleatics and by misconceptions of Aristotle, and adorned by its old-world poetic references,—starts from the Orphic myth of an Eros, or Love older than the passion-firing Cupid, sprung from Zeus and Aphrodite, the primeval issue of Chaos, sire of gods and men and all animated things, "that light whose smile kindles the universe," and gives to it an interpretation which, in Aristotelian language, amounts to the assertion that Chaos unformed is mere δύναμις, while Eros is ἐνέργεια, matter actually existing as a formative cause, the first principle and starting impulse of phenomena. Bacon

begins his arguments by a refutation of the view that the original of things is to be found in matter without form—a view he attributes to Aristotle (who disclaims it in his reference to Hesiod and others, οἱ ἐκ νυκτὸς γεννῶντες,) not perceiving that the Aristotelian πρῶτη ὕλη is as mere an abstraction as the pure εἶδος, and that, in all intelligible philosophy, the universe consists of their various unions. Passing from the rude mass of void and formless chaos, he comes to consider "matter itself,"—*i.e.*, substance in the first sense in which it has any meaning to us—and finds its nature more or less clearly shadowed in the fable. Primary matter, possessed of some definite qualities, without which its existence would be to us wholly inconceivable, it is vain for us to look beyond; and hence we are told that the parents of Eros are unknown. "It is the cause of causes itself, only without cause next to God." "Nothing was before it, . . . neither genus nor form; . . . whatsoever its power and operation be, it must be taken absolutely as it is found. . . . For there is a true limit of causes in nature; and it is as unskilful and superficial to require a cause when we come to ultimate force and positive law, as not to look for a cause in things subordinate." If, however, we insist on pushing the question, On what do the primary qualities themselves depend? Bacon can only answer,—on the "lex summa essentiæ atque naturæ—vis scilicet primis particulis a Deo indita, ex cujus multiplicatione omnis rerum varietas emergat et confletur." Whether this law can ever be discovered, he does not say,—"it is a thing which the thoughts of man may offer at, but hardly take in;" but in philosophy we must start from qualified or formed

matter, for "that which primarily exists must no less exist than that from which it derives existence, and in Scripture it is not said that God created ὕλη, but heaven and earth."[1]

The fancy, poetised by Aristophanes, that the egg of Eros was laid by night, Bacon declares to point to the exclusions and negatives by which we arrive at laws. Our knowledge of true forms emerges from the darkness of ignorance, and in the process we do not know what may be evolved from it. These natures need have no outward resemblance to their manifestations; the primitive qualities can only be reached by exclusions, for they do not touch the sense, and Democritus "did excellently well in teaching that atoms were unlike anything sensible, . . . saying that they resembled neither fire nor anything else that could be felt." The same philosopher is, however, blamed for inconsistency in detail, giving the atoms upward and downward motions, impacts, and *motus plagæ* of ordinary bodies: whereas the Parable exactly maintains the true view of heterogeneity—*i.e.*, "a strongly marked antithesis between the fundamental qualities of matter and the sensible qualities of which alone we are directly cognisant." It has been correctly pointed out that Bacon's manner of handling it shows that his conception of the atomic theory was consistent with its most modern developments: that, when freed from the hypothesis of fixed size, figure, &c., really belonging to compound bodies, which he rejects, "the atomic theory becomes a theory of forces only; and of whatever ulterior developments it

[1] Throughout this compulsorily brief account I have collated with my own reading of Bacon's Essay the analysis of Mr Ellis.

may be capable, these can only be introduced when it has assumed this form." Such, in a crude shape, was perhaps the vaguely defined idea of Pythagoras[1] (though he has been accused by Thirlwall of confounding a geometrical point with a material atom), and some of his conceptions received a new life in the seventeenth century in the Iatro-Mathematical school of Chemistry. Such more undoubtedly were the speculations of Boscovich and the monadism of Leibnitz.

Having disposed of the first of the cosmological errors, which consists in making Cupid identical with Chaos, or formless, and therefore unimaginable, matter, Bacon discusses those which, at the other extreme, endow him with secondary qualities. "Ita personatus est (*i.e.*, he is a person, not ὕλη) ut sit tamen nudus." The actual existence of separate forms has been asserted by some, of separate matter not even by those who have taken it for a principle; and "to constitute entities from things imaginary seems perverse;" but the pre-Socratic ancients, agreeing in their views of matter as active and formed, fell, with the exception of Democritus, into one or other of three mistakes:—

1. Throwing a *veil* over the naked Cupid—*i.e.*, deriving the diversity of things from one physical principle. Under this head we have a critical survey of the views of Thales, Anaximenes, and Heraclitus, who resolved all the manifestations of nature into water, air, and fire respectively—a survey which may be compared with the often closely corresponding passages in the first Book of Lucretius, 'De Rerum Naturâ.'

[1] In the 'Cogitationes de Rerum Naturâ,' Bacon draws a parallel between the atoms of Democritus and the number of Pythagoras.

2. Giving Cupid a *tunic*—*i.e.*, referring everything to the influence of two or more opposing principles, as the love and strife of Empedocles and Parmenides. Among the followers of the latter he ranks Telesio; and a great part of the book is occupied with objections to the details of his system, which the critic (owing to his many points of agreement[1] with its author) treats with careful respect. Telesio and his followers are censured for empiricism in their use of the conceptions of *heat* and *cold;* for astronomical errors which Bacon does little to correct; and for omitting to consider facts relating to the impenetrability, indestructibility, cohesion, and attraction of matter. They are also blamed for indulging in "a pastoral philosophy, which contemplates the world placidly and at its ease." In the course of this discussion, stress is laid on the Dualism which lies so much at the root of nature and history, in antagonistic forces or productive powers,—as the principle of sex, the conflicts of morals, and the "constant interchange of light and bloom," in the manifestations of the universe.

3. Giving Cupid a *cloak*—assuming an infinity of principles externally like their products. An examination of this error) represented by the ὁμοιομέρεια of Anaxagoras), is deferred for the unwritten treatise on "Cœlum." Its place is hardly supplied by the fable of that name that appears in the 'De Scientia Humana' and 'De Sapientiâ Veterum,' which is a mere picturesque rep-

[1] Telesio's view of the nature of the soul is nearly identical with Bacon's, especially in his holding the *spiritus* that pervades the animal and vegetable world to be a material essence, which in its turn is inspired by a spark of the divine soul. The ideas of a soul of the Universe in Campanella and Bruno are more nearly represented by Wordsworth.

resentation of the development of things from the void, with carefully guarded theological caveats and confused references to Genesis and heathen mythology, where Saturn is assumed to typify matter as it existed formless, before the six days' work.

Finally, as far as we can discern, the true view according to Bacon remains with a corrected Atomism—that there is only one material but comparatively undefined principle, "idque fixum et invariabile" (a point on which he is inconsistent), and this is intended to be conveyed by the assertion that Cupid is "personatus" yet "nativus et exutus," clad only in his wings.

CHAPTER V.

'DE SAPIENTIÂ VETERUM'—SUMMARY—BACON'S INFLUENCE.

We are told that, next to the 'Essays,' Bacon's 'De Sapientiâ Veterum' (1609) was during his life his most popular work,—a verdict for which its constant literary charm and suggestive touches, with the passion for allegory that in his age still survived, sufficiently account. But it is also one of the best mirrors of the author's mind, equally reflecting his caution in politics and religion, his audacity in criticism, his inconsistent conservatism and innovation in science. We are not here concerned to discuss the validity of the speculative Euhemerism, which may be compared with earlier Ethical and later Philological under-readings. It is enough to note that nowhere is the constraining power of the central idea to which Bacon made all things do homage, more manifest than in the richly varied fancies of an alchemy turning the myths of the world's youth into the gold of his new philosophy. Throughout the whole of those often strangely forced but always shining comments, every phase of interpretation is employed to convey the writer's sense of the patience required and

the lures to be resisted in the search for Truth. The seeker is:—Mercury restoring the sinews of Jupiter—*i.e.*, the cunning hand to an age of enterprise; Prometheus, eldest runner in the race of thought, transmitting through generations the torch of light; Œdipus, who wrested her secrets from the Sphinx; Odysseus, who "would not make his judgment blind," yet bound his will from the Sirens; or, higher, Orpheus, who oversung them with the praises of the gods. The servant of the Muses will not spend the youth of Narcissus in self-regard, to live the age of Tithonus in self-satiety, fruitless and careless, and "passing traceless, as the way of a ship on the sea;" but, like the musician whose lyre moved stones and trees, he will dig again the springs of Helicon, and dare Hades to revive the truth, earning immortality by merit and renown. The benefactor of mankind must disdain the arts of Dædalus to hearken the songs of Apollo: he will not, as Vulcan, try to force Minerva; but win her to the bridals of earth and sky: he will recognise that Art is swifter than Nature if it turn not aside, with Atalanta, for the prizes of the market. The wise moralist will shun the flight of Icarus, and steer the middle way. The spokesman of Metis, not satisfied, like Cato, with the part of Cassandra, will put his hand to the helm of the State; but he will never forget that presumption is the prey of the winged Nemesis, daughter of "Ocean and Night, that is the vicissitudes of things, and the dark and secret judgments of God,"—Nemesis on which "the curious and malignant nature of the vulgar," exulting "when the fortunate and powerful fall," has set a crown. The fable of Prometheus as Providence most strikingly

concentrates the practical side of the writer's philosophy.

"The chief aim of the parable appears to be, that man, if we look to final causes, may be regarded as the centre of the world, insomuch that if man were taken away from the world, the rest would seem to be all astray, without aim or purpose—to be like a besom without a binding, as the saying is, and to be leading to nothing. For the whole world works together in the service of man, and there is nothing from which he does not derive use and fruit. The revolutions and courses of the stars serve him both for distinction of the seasons and distribution of the quarters of the world. The appearances of the middle sky afford him prognostications of weather. The winds sail his ships and work his mills and engines. Plants and animals of all kinds are made to furnish him either with dwelling and shelter, or clothing, or food, or medicine, or to lighten his labour, or to give him pleasure and comfort; insomuch that all things seem to be going about man's business, and not their own. Nor is it without meaning added that in the mass and composition of which man was made particles taken from the different animals were infused and mixed up with the clay; for it is most true that of all things in the universe man is the most composite, so that he was not without reason called by the ancients the little world. . . . .

"Prometheus applied himself with all haste to the invention of fire, which in all human necessities and business is the great minister, . . . insomuch that if the soul be the form of forms, and the hand the instrument of instruments, fire may rightly be called the help of helps and the mean of means. . . . But the accusation against him—*i.e.*, preferring of complaints against nature and the arts—is a thing well pleasing to the gods, and draws down new alms and bounties from the divine goodness. 'Discontent with what we have attained is more profitable than overflow of congratulation, for conceit of plenty is the cause of want.'"

Among Bacon's warning apologues, the most emphatic is his treatment of the tale of Diomedes; who, for wounding Venus in the hand, led a life under ban, till even Daunus his host slew him, as a man hated by heaven, who had assaulted "with the sword a goddess whom it was forbidden even to touch;" and his followers, who bewailed him, were changed into swans, who had to sing at their own death. Such is the fate of those who violently attack even a vain religion—a thing set apart, and touched at the peril even of those who pity the rash reformer. With this in view, Bacon seems to close his 'Cœlum,' or fable of "the Origin of things."

"It must be said, however, of all this, that, as there is philosophy in the fable, so there is fable in the philosophy; for we know that all such speculations are but the oracles of sense, which have long since ceased and failed—the world, both matter and fabric, being in truth the work of the Creator."

In the same spirit, he asserts that the crime for which Prometheus was chained to Caucasus is

"no other than that into which men fall, when puffed up with arts and knowledge, of trying to bring the divine wisdom itself under the dominion of sense and reason, from which attempt inevitably follows laceration of the mind, and vexation without end or rest; and therefore men must modestly distinguish between the oracles of sense and of faith, unless they mean to have at once a heretical religion and a fabulous philosophy. . . . The voyage of Hercules, sailing in a pitcher to set Prometheus free, seems to present an image of God the Word hastening, in the frail vessel of the flesh, to redeem the human race. But I purposely refrain myself from all licence of speculation in this kind, lest peradventure I bring strange fire to the altar of the Lord."

Every passage in which Bacon has referred to revealed

Religion has the same note. In the short Ninth Book of the 'De Augmentis,' having sailed round the world of sciences, it remains for him to "pay his vows"; proceeding further, he would have to "step out of the bark of human reason and enter into the ship of the Church, which is only able by the divine compass to direct its course. Neither will the stars of philosophy, which have hitherto so nobly shone upon us, any longer supply their light; so that on this theme silence is golden." To remove all ambiguity, he adds: "As we are bound to obey the divine law, though we find a reluctation in our will, so we are to believe the Word of God, though we find a reluctation in our reason;" and proceeds to state that "if we believe only that which is agreeable to our sense, we give consent to the matter and not to the author. . . . Sarah's laugh at Abraham's faith was 'an image of natural reason.' . . . Sacred theology ought to be derived from the oracles of God, and not from the light of nature. . . . It is written, 'The heavens declare the glory,' but nowhere that they declare the will, of God. 'Love your enemies' does not sound human: it is a voice beyond." When, indeed, the articles of religion have been set in their place, wholly exempt from the examination of reason, it is then permitted us to draw inferences, "as to play a game of chess according to the rules; but the 'placets' of God are removed from question." That Bacon's position is not that of the Arabian Algazel[1] is plain: nor was it even, at all events

[1] Renan's judgment on the results of Algazel's teaching marks decisively the gulf between him and Bacon: "Ceux qui, après avoir philosophé, embrassent le mysticisme en désespoir de cause, sont d'ordinaire les ennemis les plus intolérants de la philosophie. Gazali,

avowedly, that of the Italian Pomponazzi, to whom he was more akin; for he constantly protests against the idea that what is false in philosophy may be true in faith. "There is no such opposition between God's Word and His works,"—each has its sphere, the one surpassing but not contradicting the other; and many of his assaults on the scholastic mode of thought are levelled against the habit of confounding them by absurd interpretations: as when ('De Augmentis,' iv.) he writes: "In this vanity some have with extreme levity indulged, so far as to attempt to found a system of natural philosophy on the first chapter of Genesis, or on the Book of Job." Similarly, he objects to Paracelsus deriving philosophy from sacred works, as if all other were profane and heathen; asserting that "to seek philosophy in divinity is to seek the dead among the living; to seek divinity in philosophy is to seek the living among the dead." The most distinct statement of his view between the two extremes is in the 'Valerius Terminus':—

"I make a bank to rule the waters by setting down this firmament, that all knowledge is to be limited by religion and to be referred to use and action. For, if any man shall think, by inquiry into these material things, to attain to any light for the revealing of the nature or will of God, he shall dangerously abuse himself. . . . The contemplation of the creatures of God hath for end knowledge; but as to the nature of God no knowledge but wonder, which is nothing else but contemplation broken off or losing itself. Nay, further, as it was aptly said by one of Plato's school, the sense of man resembles the sun, which openeth and revealeth the

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devenu soufi, entreprit de prouver l'impuissance radicale de la raison, et, par une manœuvre qui a toujours séduit les esprits plus ardents que sages, de fonder la réligion sur le scepticism."

terrestrial globe, but obscureth and concealeth the celestial:[1] so doth the sense discover natural things, but darken and shut up divine. . . . 'God is only self-like, having nothing in common with any creature, otherwise than in shadow or trope. Therefore, attend His will as Himself openeth it, and give unto faith that which unto faith belongeth.' . . . But there are which, in a contrary extreme, do offer too great a restraint to lawful knowledge. . . . If they mean that the ignorance of a second cause doth make men more to depend on the providence of God, as supposing the effects to come immediately from His hand, I demand of them, as Job of his friends, 'Will you lie for God as man will for man to gratify him?'

"There are two reasons why religion should protect all increase of natural knowledge: . . . the one because it leadeth to the greater exaltation of the glory of God; . . . if we should rest in the contemplation of those shows which first offer themselves, . . . we should judge of the store of some excellent jeweller by that only which is set out to the street; . . . the other because it is a help against unbelief. The later book will certify us nothing which the first teaches shall be thought impossible. . . . Most sure it is . . . that a little philosophy inclineth the mind to Atheism, but a further proceeding bringeth it back to Religion. . . .

"A religion that is jealous of the variety of learning, discourse, opinions, or sects (as misdoubting it may shake the foundations), or that cherisheth devotion upon simplicity and ignorance, as ascribing ordinary effects to the immediate working of God, is adverse to knowledge. Such is the religion of the Turk, and such hath been the abuse of Christian religion."

Bacon's two apparent attitudes on this question recall his own distinction between nature free and nature in

[1] This passage may have suggested the well-known sonnet of Blanco White:—

"Mysterious Night, when our first parents knew
Thee by report divine, and heard thy name," &c.

bonds. When he regards the universe as a great commentary on the work of God, he writes as a rationalist: "It were better to have no opinion of God at all than such an opinion as is unworthy of Him." When he contemplates the invisible Church of all the faithful, or the visible Church of his steadfast though politically Erastian Anglicanism, he accepts the doctrines of the Fall and its consequences, the Trinity, Justification by Faith, Miracles, &c., without reserve, and on entering the precincts of the temple throws off the shoes of his philosophy. The fact that Bacon's philosophy was, though aspiring, mainly terrestrial; that its basis was apart from religion; the empirical consequences drawn from it in the eighteenth century, together with his own almost exclusive predilection for positive science, the absence in his works of any appeal to the hopes and fears of a future life, and the worldly motives which actuated so much of his own career,—have (as in the cases of Pomponazzi and Galileo) given rise to the widespread belief that his orthodox protestations (in an age when "free thought" was widely though secretly spreading) are mere conciliatory instances of his own "custom in dissimulation,"—concessions more or less transparent to prudence or to power. It has been maintained that "all his tributes to religion do not outweigh his neglect of it as a central motive;" that his Christianity, further than the admitted genuineness of his pity for human suffering, is the lip service of a man who, with the fates of Bruno, Campanella, and Vanini before his eyes, lived in fear of being arraigned for heresy; that he treats sacred texts as he treats old fables, making them handles for his purpose to impress

and give weight to his preconceived ideas; in fine, that his Protestant orthodoxy is a mere matter of style, like the Catholicism of Montaigne or Rabelais. On the other hand, it is argued that "no spirit of irreligion has inspired any of Bacon's works," that no one of them is calculated to weaken any dogma of faith, and that many of his positive affirmations, as in his "Confession," "Meditationes Sacræ," his prayers and letters *passim*, were made under no inducement to hypocrisy; when thrown out of gear with the world, and on his own resources, he was most likely to be sincere. On this vexed question it may at least be asserted with confidence, that the extremist zeal of such writers as Joseph de Maistre, imputing to Bacon cryptic Atheism, and a desire to propagate it, absurdly errs; and that the Abbé Eymery, who, about the same date, cited his name as a religious philosopher, in opposition to those of D'Alembert and Diderot, was more nearly just; for if Bacon's system is not reared on religious sentiment, it leads to that sentiment as its crown.[1]

[1] With the following judgment of an eminent scholar and thinker I entirely agree: "It is rare to find a scientific man who has much interest in, or understanding of, religious problems. From Boyle to Brewster, they are content to accept the prevailing orthodoxy as something given, and only attack it on outlying points if it attacks them. Bacon was so far a scientific man that his treasure and his heart were set on the natural world. But, further, he was a philosopher; and his philosophic insight, coupled with his devotion to the world, also determined him to leave religion alone. For he must have seen, and he did see, that his methods applied to theology would upturn everything; and he must also have known that this could not but rouse

It remains briefly to summarise the defects and the intent of the New Philosophy, and to offer some estimate of its after-influence. Bacon's weakness as a critic is manifest. Denouncing tradition, commanding

in arms against his method the very sentiment which *it was the aim of his life to conciliate* on its behalf. There were recent examples in plenty of the 'heretical religion' that natural philosophy produced when it laboured on theologic ground, and it had aroused antagonism both among Protestants and Catholics. Nor was he blind to the evils of the 'fantastical philosophy' which the works of such men as Paracelsus, &c., exemplify. Bacon, as a man of science, was almost exclusively interested in nature; as a philosopher, he was able to see where the interest was endangered. No man pursues his theories to their last consequences in all directions. So it is not wonderful that he stopped short when it suited him—availing himself, in order to do this, of a distinction, current in the ordinary thought of the time, in previous philosophy, and certainly not excluded from his own system, so long as it is regarded from one side. But, however other interests may habitually divert the religious interest, the latter cannot be altogether ignored. It asserts itself as an element of culture and as a personal need. As an element of culture, Bacon's intellectual inquisitiveness could not leave it alone: even when he had dismissed it from his scheme of philosophy, it could not be effaced from the map of the 'Globus Intellectualis.' So he manages to find a *quasi* justification for correcting its results, even if he leaves its data untouched. Doing this, however, as an amateur, he does not go so far as to discover that such correction would ultimately affect the data themselves. When he has recourse to it from a personal motive, as in the prayer when under a cloud, he, from his previous disregard of the subject in its essentials, has no option but to accept it in its orthodox form, only translating it into the language of his own individuality."

a return to experience, his own facts are drawn more from books (in which, he says, "we converse with the wise, as in action with fools") than from nature. Hence he was only able to suggest, not to realise; and was withheld from setting a firm foot on the shore of his America, or conquering, like Alexander, any part of his kingdom. His inaccuracies of detail, his indifference to the psychological problems of consciousness, sensation, perception,—to the relation of the ego and the non-ego, of space and time, the origin of knowledge, &c.,—are due partly to the limitations of his mind, in part to his surroundings. No man can leap beyond his own shadow, hardly one beyond the shadow of his age. His inconsistencies belong to his marginal standpoint, to his love of antitheses, to his insistence on minutiæ, and the hasty presumptions that led him to disdain them. His confusion of relations with elements is an inheritance. His acceptance of an unproved physiology reminds us that biology has yet failed to define life. In chemistry he is at least never retrograde. His definite errors are largely counterbalanced by his anticipations. The fundamental misconceptions which vitiated his system are radical, and may be set in contrast with the correct conclusions of Laplace :—

"The sure method in the search for truth consists in rising from phenomena to laws, and from laws to forces. Laws are the links of phenomena: when they have disclosed the principle of the forces from which they are derived, it is left to verify the last, when possible, by experience, or by examining whether the conclusion satisfies the phenomena. If by a rigorous analysis we see that all the facts, however

numerous and varied, can be derived from this principle, science then acquires the highest degree of certainty that it can attain. Such has astronomy become by the discovery of universal gravitation."

L. Bacon had, as we have seen, set before himself, as the goal of his research, an unattainable end. It has been said that, like Plato, he asked too much; and thought to solve mysteries which Nature by no torture or binding of Proteus has been ever forced to reveal. We may weed his work of its contradictions, as his admission of compound "forms," his speaking of heat as "simple," and yet seeking to resolve it. We may grant that he has pointed the way to the analysis of Nature: but to ask the meaning of her primitive qualities is to batter at the last gate of Spenser's 'Busiris,' bearing the inscription, "Be not too bold." Bacon's audacity in this respect contrasts with the modest temperance of more practically successful men of science, who owed their triumphs in large measure to self-restraint. Leonardo da Vinci achieved so much because he did not confuse his experiments with pseudo-metaphysical or *a priori* fancies. Copernicus, in laying down the first draft of the planetary motions approximately true, disclaimed any inquiry after their causes. Galileo, on the same theme, declares, "The cause of the acceleration is not a necessary part of the investigation." Gassendi, in acknowledging, with polite censure, Lord Herbert of Cherbury's fantastic book, confesses that he does not believe any more than Butler, the satirist, in finding "first nature undressed." "I am in darkness when I attempt to investigate the real nature of

the least thing." And Newton admits, "The cause of gravity I did not pretend to know." "To ask what gravity is, is to mistake the last, perhaps unattainable, step for the first;" and the attempts to explain it by elastic ethers or Cartesian vortices have always been open to the charge of "obscurum per obscurius." When Bacon, after praising Galileo's optical instruments as skiffs or barks that opened a new commerce with the heavens, objects to his experiments stopping short with a few discoveries, he shows his want of appreciation of the limits of human power, and of the modesty of a true discoverer. His own aim was "to storm and occupy the citadels of things," and find their Forms. But Causes are not "Forms." "The laws and determinations of actuality" are beyond our reach, and no inquiry into "the divisions and veins of Nature" would enable us to attain them. Nor can we by any means "be freed from the common course of Nature, and expanded to new modes of operation." In the 'Organum' it is assumed that the ultimate cause of any quality will always be single—*i.e.*, that it will always have one Form; but, as far as analysis has been able to go, this is not the fact; and Bacon, though ('Novum Organum,' ii. 17) anticipating the objection that forms may mix and combine things heterogeneous, fails to meet it by the mere assertion that we are "held in captivity by custom." Substances cannot always be resolved into an aggregation of simple elements: nor movements, to all appearance identical, be referred to the same sources, for the same effect is not always produced by the same cause: it may be the product of $a + b = c$, or $x + y = c$. Bacon neglected to consider the

new established facts of the Plurality of Causes and intermixture of effects which makes the realisation of his "Forms" impossible.[1]

II. Bacon overstretched the sphere of his method. As we have seen, he thought it would apply to Ethics as well as to Physics, and proposes to construct Tables, Positive and Negative and Exclusive, of Anger, Fear,

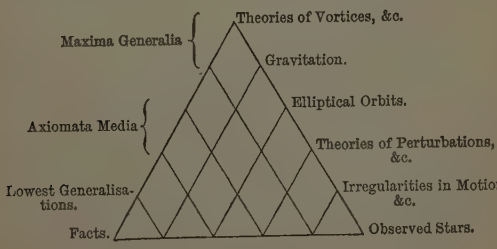
[1] Mr J. S. Mill ('Logic,' vol. ii. pp. 110, 111) adds, as follows, some important considerations, which give a wider scope to the above criticism: "The methods of induction applicable to the ascertainment of causes and effects are grounded on the principle that everything which has a beginning must have some cause or other; that among the circumstances which actually existed at the time of its commencement, there is certainly some one combination on which the effect in question is unconditionally consequent, and on the repetition of which it would certainly again recur." But, he proceeds to show, as regards a property as blackness or a sensation as pain, we have no such certainty, for each may arise from a various, if not utterly indefinable, consensus of causes. . . . "To overlook this grand distinction was the capital error in Bacon's view. . . . The *principle of elimination* —that great logical instrument *which he had the immense merit of first bringing into general use* — he deemed applicable in the same sense, and in as unqualified a manner, to the investigation of the coexistences as to that of the successions of phenomena. He seems to have thought that as every event has . . . an invariable antecedent, so every property of an object has an invariable coexistent, which he called its form; and the examples he chiefly selected for the application and illustration of his method were inquiries into such forms. . . . Such inquiries could lead to no result. The objects seldom have any such circumstance (one general property) in common. They usually agree in the one point inquired into, and nothing else. . . . A great proportion of the properties . . . likeliest to be really ultimate would seem to be inherently properties of many different kinds of things, not allied in any other respect. . . . As for the properties we are able to give some account of, they have generally nothing to do with the ultimate resemblances or diversities in the objects themselves, but depend on some outward circumstances, as is the case with the favourite subjects of Bacon's scientific inquiries—hotness, coldness, solidity, fluidity, &c. They are often coexistences independent of causation."

Hatred, Love, as of Density, Heat, Cold. There is no doubt that, by fixing attention on the necessity of collecting, testing, and comparing facts, sciences such as Political Economy and Sociology, as well as Physics, have been advanced; and this principle has in recent times been largely applied by such writers as Comte, Mill, and Buckle. But when stated, as in the 'Novum Organum,' without reservation, it ignores the difficulty if not the bar arising from the peculiarly complex action, if not the absolute freedom, of the human will—a problem which Bacon wholly ignores. In Morals we cannot, as in Physics, submit nature to unrestricted tests: our perceptions refuse to be decomposed in a crucible, or our passions to be divided by a prism. Knowledge of the mental powers is a sort of experience: History and Biography are Observations on mankind. Medicine, Education, the effects of Punishment and Reward, are in a sense Experiments; but the uniformity of nature does not hold good in the same degree in the Moral as in the Physical world. We can only avoid the Idola, and place ourselves in the right attitude for seeing the truth.

III. Bacon overestimated the precision of his method: for the mathematical or geometrical certitude on which he relied rested on unattainable conditions. He held it to be such when complete "ut non multum ingeniorum acumini et robori relinquatur, ut faciamus intellectum humanum rebus et naturæ parem," so that once in possession of it, all intellects might work alike. Macaulay's criticism fairly meets this view. No method will bridge the gulf between a dunce and a man of genius; nor even in physics is it possible to attain the vantage-ground of such absolute confidence. We cannot map out nature or catalogue her phenomena, so as to exclude new con-

tingencies, or exhaust her negative instances. Exclusions are only decisive when the subject-matter is finite; and experience can never prove that a contradictory is impossible.

IV. There is a serious error expressed, 'Novum Organum,' i. 19, where it is laid down as a rule that we must, in our search for truth, proceed by an exhaustive process—*i.e.*, from the lowest particulars to those above, and so on, including all the facts, and reaching general principles only at the end of our journey. Bacon is not himself faithful to this rule, nor has any discoverer been so. He is right in pointing out that the chief value of most sciences lies in their "axiomata media"; for the higher generalisations rest for their proof on the lower, and are too vague, and include too few circumstances for general use; while the lowest generalisations, until resolved into middle principles, are for the most part empirical. But he is wrong in asserting that our road in discovery *always* lies from the lowest to the middle, and from these to the highest principles; for in practice the highest are often ascertained first, and the middle deduced from them. The history of Astronomy, and Bacon's own image of knowledge as a pyramid, may illustrate this—



In Astronomy the middle collegations of facts were deduced from the highest law really attained, that of Gravitation. "In such cases," says Sir John Herschel, "the inductive and deductive methods of inquiry may be said to go hand in hand, the one verifying the conclusions deduced by the other; and the combination of experiment and theory . . . forms an engine of discovery infinitely more powerful than either taken separately." Nature being inexhaustible, we cannot always wait to ascend step by step, and truth must often be caught by the application—which Bacon indeed collaterally recognises in his 'Permissio Intellectus'—of an idea to affirmatives. Almost every advance in science involves a new conception, and the genius of a discoverer lies in his power to leap at the law by means of a hypothesis to be afterwards verified. Bacon's 'Alphabet of Science,' were it possible, would only represent the present state of an ever-extending knowledge. He ignored the necessity for a divining power in science, and so underestimated the value of the Deductive Method.

M. de Rémusat, erroneously taking Bacon as a type of English common-sense, and so ignoring the more than insular imagination that preferred 'Experimenta Lucifera' to 'Experimenta Fructifera,' yet admits that some forms of common-sense amount to genius, and that it is difficult for us now to realise the importance of the revolt from the substitution of memory for experience, of the rebellion against the old doctrines, which acted as the police of the sciences. The same critic asserts that the 'Novum Organum' spoke for the age in giving it a voice, and that there is a consensus of three centuries in its favour. But there is nothing to show that the work

was at first received in England with any enthusiasm. Most of those, as Bodley and Matthews, to whom it was sent, seem to have been afraid of its novelties, and guarded in their utterances. The only cordial welcome that has come to us is that of Sir Henry Wotton, who wished to send the work to Kepler, saying on its reception, "The scholastic philosophy has ceased to exist," and that of Professor Collins of Cambridge, who confessed to Rawley that, after reading the 'De Augmentis,' he had to begin his studies anew;—unless we add that of Isaac Walton, who named the author "the great secretary of nature and of science." Francis Osborn ('Miscellanies,' pub. 1659) says that a clamour of atheism was raised against Bacon; and Oldenburg, the first secretary of the Royal Society, admits that even after the publication of his great works, he stood in need of a warrant or surety from all learned Europe. His testamentary appeal "to foreign nations" seems to imply that he looked to the Continent for a wider recognition; and that his expectation was not wholly in vain is shown by several testimonies, one of the earliest that of the mathematician Marin Mersenne, who, in his 'Vérité des Sciences' (1625), speaks of the Idola as the four buttresses of the 'Organum' of Verulam. Another Frenchman, A. Ballot, says that when Descartes was in Paris in 1626, and heard the news of Bacon's death, he, with all who cared for the establishment of philosophy, were profoundly affected by it. Descartes himself, little noted for displays of enthusiasm regarding his famous contemporaries, writes to Mersenne, "You desire to know how best to make experience useful: on this point I have nothing to add to Verulam;"—add-

ing a wish that some one would write the history of astronomy according to Bacon's method: he elsewhere refers to the fulfilment of the prophecy of the Chancellor of England, "multi pertransibunt et augebatur scientia." Descartes' opponent, Pierre Gassendi, yet praises him for his points of resemblance to Bacon, whose logic, he says, is consecrated to truth, and from the pursuit of whose method we may expect the development of a new and at last perfect philosophy. Further on in the century, Puffendorf, the jurist, declares, "It was the late Chancellor Bacon who raised the standard and urged on the march of discovery;" and at its close, Boerhaave, the chemist, professes his belief that Descartes owes all that is best in him to the same source. This assertion is undoubtedly open to dispute; for between the 'Novum Organum' and the 'Discourse on Method' there is little in common save the same protests against authority, and some rules of observation apparently transferred from the earlier to the later work. The two great innovators both started by analysis, but of different objects, and drew their sources, as it were, from opposite sides of the same ridge. The Idealism of Descartes culminated in Spinoza, in whom the latent antithesis to Bacon reaches its climax: the aim of the one thinker was, as stated by Kuno Fischer, free contemplation attained when outward things cease to govern us; the aim of the other was culture and power attained when we have been taught to govern outward things. The adherents of each remain in an attitude of antagonism, that can only be reduced by the "conciliation of contradictories." It has been dogmatically asserted by proficients in either department, that the course

of Mental Philosophy since the middle of the seventeenth century has been Cartesian; of Physical Science, Galilean; and that there is no room for Bacon, save as a maker of fine phrases. The grain of truth in the former assertion lies in the fact that Descartes gave to philosophy the psychological basis adopted by Hobbes[1] and Locke and Hume, equally with Berkeley, Reid, and Kant. But the difference between the two groups is, that the spirit of the former, as that of Bentham, Mill, and Comte, is more Baconian than Cartesian. From the 'Instauratio Magna,' or its influences, they have inherited and transmitted that mode of thought which refers science for its source to observation, discards innate ideas, subordinates metaphysic, and inclines to refer psychology to physiology. Bacon himself was not a materialist, but it may be admitted that the exclusive application of the inductive method to mental science tends to materialism. One of the earliest suspicions of the fact is recorded in the confession of a reactionary royalist of the century, H. Stubb, that he had been for a time led astray by the mechanical school; but it does not seem to have aroused systematic antagonism till D'Alembert and Diderot inscribed Bacon's name on the front of

1 Hobbes, though among the personal friends of Bacon, seems to have received from him directly only casual suggestions—*e.g.*, as to the influence of self-love among the motives of life; and does not name him when, in his preface to the 'Elementa Philosophiæ,' he dwells on the revival of science promoted by Galileo, Kepler, and Harvey. He only cites Bacon twice incidentally in reference to the movements of the sea and an experiment on water (*vide* Rémusat, 'Bacon, sa Vie, son Temps, sa Philosophie,' pp. 405-409), and never speaks of Induction in his Logic save in his controversy with Wallis—his own philosophy, though sensational, being almost purely deductive. Similarly, Locke is only indebted to the 'Organum' for the basis of the Book III. of his "Essay" in the 'Idola Fori.'

their Encyclopédie[1] — the former saluting him as the most universal of philosophers, and the latter adopting the title 'De Interpretatione Philosophiæ' for one of his sceptical books. When the National Convention decided to publish his works at the expense of the State, their patronage provoked the retaliation of De Maistre and others, who "only saw incendiaries in the bearers of the torch." Meanwhile, during the seventeenth century in England, where Bacon's esoteric method remained in abeyance, the influence of his exoteric Physics was beginning to prevail. It is admitted that the suggestion of the "College of Philosophy," instituted in London (1645), and after the Restoration extended into "The Royal Society" (1662), was due to the prophetic scheme of "Solomon's House"[2] in the 'New Atlantis.' Wallis, one of the founders of the "Society," exalts him by name, along with Galileo, as their master. Sprat says, "It was a work becoming the largeness of Bacon's wit to devise and the greatness of Clarendon's prudence to establish." Boyle[3] invokes for its inauguration "that

[1] In which the classification of the sciences in the 'De Augmentis' is distinctly adopted.

[2] The earliest suggestion of this appears in the 'Praise of Knowledge' (*v. ante*), where Bacon writes: "I will recommend to your Highness four principal works and monuments—1. The collecting of a most perfect and general library; 2. A spacious (botanical) and zoological garden; . . . 3. A goodly cabinet wherein whatsoever the hand of man by art or engine hath made, . . . whatsoever singularity chance and the scuffle of things hath produced, . . . shall be sorted and included; . . . 4. A still house so furnished with mills, instruments, furnaces, and vessels, as may be a place fit for the philosopher's Stone."

[3] Many of these testimonies to Bacon's influence are given by Macvey Napier in the 'Transactions of the Royal Society of Edinburgh,' vol. viii. pp. 373 *et seq.*

profound naturalist, . . . our great Verulam." Dr Hooke, asserting that Bacon alone, among preceding thinkers, conceived the idea of a mental engine for discovery in the 'View of Natural Philosophy' (pub. 1705), professes himself his disciple, and maintains that physical as well as mathematical inquiries are capable of demonstration. Evelyn in his 'Sylva,' and Glanvill in his 'Plus Ultra,' bear the same testimony. It is of more consequence to remark that the tree which Bacon planted was beginning to bear fruit in his successors, by whom more was done in two than by his predecessors in twenty centuries; that the false methods he condemned were little by little abandoned; that his idea of working on facts by "scala" of ascension was accepted; that certitude was being added to his novelty, and the great lacuna in his system, a neglect of the path downwards from generals to particulars, supplied in the contributions to his 'Scientia Activa,' made by Boyle, Newton, Linnæus, Cuvier, and others. If Newton owed anything to Bacon, he does not acknowledge it; but it is confessed that his "analytical method" has close points of contact with the Baconian Induction, that both are inspired by the same ruling ideas of the relation of cause to effect and the stability of Nature's laws, of method as a means of gradual ascent to the solution of natural problems; and that the latter, especially in his Optics, consciously or unconsciously, avails himself of the rules of the former to an extent that justifies the remark of Horace Walpole: "Bacon was the prophet of things that Newton revealed;" of Addison, who perceives in him "the predecessor of Boyle and the rival of Newton;" or of Maclaurin, that "it only wanted Bacon

to be more listened to, to pave the way for the 'Principia.'"

During the same period, on the Continent, the new philosophy found enthusiastic advocates. A French friend of Hobbes wrote to him: "If England had only given to science Gilbert, Harvey, and Bacon, she might have disputed the palm with France and with Italy, who have given us Galileo, Descartes, and Gassendi; but Bacon has carried it over all others in grandeur of design." Boyle ranks Verulam among the greatest minds of his age. Huyghaens records his belief that Bacon succeeded in his method, and taught men to make the best use of experience, though failing in discovery from deficiency in mathematics. Vico confesses that he owed to the 'De Sapientiâ Veterum' the idea of searching for truth in mythology, and commends its author for having made the English mind familiar with the true sense of Induction. Voltaire asserts that the 'Novum Organum' is the scaffold on which the English have built their philosophy, and then let it fall. At a later date Kant himself refers to it as the work of "one of the greatest physicists of modern times."

The majority of German metaphysicians, repelled by his dogmatic protests against *a priori* views, have treated Bacon as hardly in their blame as the majority of German critics have dealt with Shakespeare in their praise. Spinoza, granting that he recounts well without proving, is inclined to regard his school as that of a superficial industrialism; and similarly Hegel has adopted Macaulay's view, without, as Macaulay does, regarding it as complimentary.

Yet it is a German of wider if not deeper mind—

not a metaphysician alone but a jurisconsult, mathematician, naturalist, linguist, and critic, the rival of Locke as of Newton, the precursor of Cuvier, Savigny, and Grimm—it is Leibnitz who has shown the most thorough appreciation of the Baconian philosophy. He conceived his own Monadism, which has been said to have "rescued Cartesianism from the abyss of passivity into which it threatened to fall," to be akin to the doctrine of the 'De Principiis,' and expressed his belief in the assertion, "We do well to think highly of Verulam, for his hard sayings have in them a deep meaning." Elsewhere he declares that Bacon recalls philosophy from space to earth and life, and has first put the art of experiment into precepts; and, classing him in some respects with Descartes, says that, as compared with the former, the latter "creeps on the ground." The effect of this acknowledged influence is apparent by the anonymous tract, "Gulielmi Placiti 'Plus Ultra,' sive initia et specimena scientiæ generalis, *de instauratione et augmentis scientiarum*, ac de proficiendâ mente, *rerumque inventione* ad publicam felicitatem;" the conclusion of which was designed to convey an exhortation to those worthy to increase the happiness of the race. In another work he refers to the 'De Augmentis' as chief among the writings of the reformers who had in his youth directed him to the right path. But the most important application of the Baconian method made by Leibnitz is his reform of the Science of Language; his decisive confutation of the presumption that all dialects must be offshoots of Hebrew; his assertion that "this study must be conducted on the same principles as those of the exact sciences, beginning from the languages best known

to us, and so ascending step by step to those more remote," thus laying the foundations of Philology as securely as Galileo and Kepler laid those of Astronomy.

A century later the Scotch Psychological school claims to be Baconian in its application of the Inductive processes to the science of the mind. Reid explicitly dates from the 'Novum Organum' the new impulse in a direction more just and more fertile than that of the Organon of Aristotle; and Dugald Stewart, regretting that Bacon has been more praised than studied, adopts his principles as converting common-sense into science, and vindicates the originality of his Logic. M. Royer Collard maintained that Inductive Reasoning had been created by the 'Instauratio Magna,' and that Bacon had supplied to Newton his leading rules with the instrument of all the discoveries one can make in Nature. M. Jouffroy followed in the same track; and Comte himself, while repudiating previous systems, assigns to Bacon a great share in the movement that first led men to conceive of an empire of science greater and more lasting than that of mere industrialism in society. To this view M. Littré adheres, and it is implicitly recognised by the followers of Bentham, Mill, Lewes, and others in England.

Among the more recent thinkers of Germany, Schopenhauer is conspicuous by the terms of generous recognition in which, though from a different standpoint, he invariably refers to Bacon, who enlists his sympathy by a frequently cynical view of the world, and a like keen sense of human suffering. Schopenhauer's assertions—"That which is acted on is always matter, and thus the whole being and essence of matter consists in the orderly

changes which one part of it brings about in another part;" "To repeat the whole nature of the world . . . in concepts, and thus to store up a reflected image of it always at the command of the reason, this and nothing else is philosophy:" with the iteration of the practical precept, "beautifully expressed by Verulam: The intellect is not a dry light. . . . Love and hate falsify our judgments entirely,"—might well have enlisted the sympathy of Bacon, to whom the great protester against the complacencies of Optimism, in the following, again refers: "Philosophy will be a sum total of general judgments, whose ground of knowledge is the world in its entirety. . . . It will be a complete recapitulation, as it were a reflection, of the world in abstract concepts, which is only possible by the union of the essentially identical in one concept and the relegation of the different to another. This task was already prescribed to philosophy by Bacon of Verulam, when he said: 'Ea demum vera est philosophia, quæ mundi ipsius voces fidelissime reddit; et, veluti dictante mundo, conscripta est, et nihil aliud est, quam ejusmodi *Simulacrum et Reflectio*, neque addit quidquam de proprio, sed tamen iterat et resonat' (De Aug., ii. 13)." Nor is the following less capable of being construed into the language of the 'Instauratio': "The bridge by which metaphysic passes beyond experience is nothing else than the analysis of experience into phenomena, and the thing in itself (*i.e.*, the Form)." Kant's merit is, that he presents to us the kernel of the phenomenon different from the phenomenon itself:—

> "Ist nicht der Kern der Natur
> Menschen in's Herzen."

Bacon is not appreciated by pure Logicians, who complain of his imperfect analysis of the Inductive process itself; and retort on his attacks on the Syllogism by reasserting its analytical value. It may be admitted that he dwelt on facts to the subordination of Dialectic, at a time when Dialectic had been excluding facts; that, in our day, a writer, inspired by the same spirit of reform, would—in view of the chaotic sentiments that take the place of argument, and the want of proportion that mars our expositions and our art—have dwelt more on the necessity of logical clearness and arrangement. But most of those adverse criticisms lack the historical sense.

Bacon is the *bête noire* and butt of Specialists, the modern Schoolmen, who resent his insufficient view of their little worlds. Mere politicians complain that he was neither a Whig nor a Tory: mere theologians see that, with all his orthodox protestations, Religion was on the fringe of his system: mere physicists, led by Harvey, who begins the attack in his dictum that he "wrote like a Lord Chancellor," dislike or distrust his metaphysics, and dwell, as Baron Liebig does, with acrimonious exclusiveness on his defects. Their comments are narrowly correct; but, like those of mere dryasdust philologists on the classics of literature, so one-sided as to be impertinent. The inaccuracies inevitable to universal views, must be conceded to the ingratitude of those prone to bite the hand that feeds them. Scientific and literary men of larger grasp—as Laplace, who refers to Bacon as "this great philosopher, the brightest man of the bright century when he ended his career;" Playfair, who says, "It is easier

to find new Galileos than new Bacons;" Herschel, who compares him to "the star that announces the day;" Mackintosh, who says, "His authority will have no end;" Mill, who, while marking his lacunæ, reveres his name; Whewell, who sets it on the forefront of his comprehensive survey; and Tyndall, whose literary grace is only less unique than that of his master,—are at one with historians like Hallam in proclaiming him the first great mover in a mighty impulse.

Bacon wanted not only the analytic skill and the attention to details but the concentration of thought essential to the precise ascertainment of any one of the laws of nature. Definite discovery was not his *métier:* it was left for Galileo and his followers to practise what he discarded. When his breadth of view is compared to that of Newton, Boyle, Leibnitz, Franklin, Laplace, Herschel, Faraday, and Rowan Hamilton, we must remember that these were all exact mathematicians as well as comprehensive thinkers. Bacon has closer kindred with Plato and Aristotle, Goethe and Humboldt: like these, even where he failed he has left his mark. His sentence on the first is applicable to himself: "A man of sublime genius, who took a view of everything as from a lofty rock." His self-criticism is sound, —"fungar vice cotis acutum reddere quæ ferrum valet expers ipsa secandi." He sharpened the instruments for others to use: he pointed the path, which he could not follow, to the walls of the citadel he failed to storm. Cowley has compared him to Moses—

> "Who did upon the very border stand
> Of that fair promised land;"

and with how keen an eye he ranged the horizon we

may infer from the forecasts of the discoveries of Boyle, Spallanzani, and Darwin, in the "Magnalia" of the 'New Atlantis' and elsewhere, scattered through his work. But his claim to have "moved the intellects that move the world" does not rest on these. Bacon made an epoch by the view he opened up, disclosing a way "to unpathed waters, undreamed shores;" by training his contemporaries to habits of investigation, and inspiring them with a share of his zeal for observation, which he first set on a rank of equal dignity with abstract thought.

He invented nothing, but he called the sciences back to their sources, and so, in the phrase of M. de Rémusat, "threw out a thought full of the future." His predecessors in reform addressed a narrower audience, and spoke in lower tones. It was only Bacon's enthusiasm through half a century maintained, his dauntless tenacity —"viam aut inveniam aut faciam,"—and his splendid powers of speech, that gave to science wings to make way through the minds of men. Dean Church admits that the tentative efforts of Bruno, Telesio, and Campanella were short flights, and that Bacon was the first to recognise the need of more thoroughness and system to match the magnitude of the work he set before his successors.

Finally, we must remember that his Philosophy was only half his work: he has built a pyramid in Law as well, and jurists still appeal to his maxims.[1] His contributions to "History" are "Imagines" of great

[1] Bentham says the Code Napoléon was suggested by Bacon's early Maxims of the Law—a sheaf or cluster towards his great scheme of codification.

rulers, so sculptured and painted as to throw a light on the causes and the limits of their power that has been generally esteemed correct, and served as a guide to his successors in this department, the philosophic historians of later times. The 'Essays,' to which we have only been able to refer, are ingots from an apparently inexhaustible mine—condensed counsels for those who would be great as well as wise, springing "from a mind hesitating whether to direct the vessel of the State or to found a new Philosophy;" mirrors for magistrates, as well as sounding-lines for discovery in our greatest age; suggestions and criticisms since beaten into gold-leaf over England, as the wisdom of Horace's Odes over Italy, till their originality has been half forgot.

"Bacon," says Hallam, "was more eminently the philosopher of human than general nature. In his 'Centuries of Natural History' he is like one making out a prospect, but often deceived by the haze. But if we compare what may be found in the 6th, 7th, and 8th books of the 'De Augmentis,' in the 'Essays,' the 'History of Henry VII.,' and the various short treatises contained in his works on morals and politics and on human nature, from experience of which all such wisdom is drawn, with the rhetoric, ethics, and politics of Aristotle, or with the historians most celebrated for their deep insight into civil society and character, —with Thucydides, Tacitus, Philip de Comines, Machiavel, Davila, Hume,—we shall find, I think, that one man may almost be compared with all of these together."

In some respects this eulogy is overstrained; for the Ethics and Politics of the 'De Augmentis' and the 'Essays' are marred by the cynicism of long waiting years, of expectations frustrated and hopes deferred; but Hallam, recognising in Bacon the philosophy of

"Coriolanus" and "Troilus and Cressida," fails to see his *rapport* with that of "Hamlet" and "The Tempest": he has nowhere done full justice to the value of Bacon's protest against authority, or to his conception of the true end of knowledge, "the glory of God and the relief of man's estate." On the first head, the judgment of Mr Ellis—who has contrasted Bacon's earnest religious tone with that of Galileo's irony, without sufficiently considering that the latter was in the lion's den—seems of more weight than that of Joseph de Maistre. Of Bacon's sincerity on the latter, no reader of the 'Instauratio' has any doubt. Nor Leonardo nor Galileo had his far-ranging view of the unity of nature and of science, or of the ultimate consilience of knowledge and practical power. He taught the truth expressed in the words of a modern poet—

> "The one becomes the whole, the whole the part,
> When through them both what each concealed is seen,"—

and pointed the way to the ideal world, where

> "Men are to man transformed, and Life to Art."

Bacon lauds Parmenides and Plato for saying, "All things by scale ascend to unity;" and he goes beyond them in his belief in principles that rule and constitute the fabric of the world. His perception of analogies, however "portentous," led him right in tracing a *nexus* in the scheme of things. He reflects and repeats the old vague efforts in the same direction,—from Heraclitus's finer fire, the start and goal of the way up and down, to Plato's triads; from the speculations on phenomena and noumena that ran through the period between Xenocrates and Zeno, to the metaphysical paradigms of the

medieval realists, physically realised in Owen's archetypal skeleton, and welcomed back in altered guise by an eloquent physical expositor of our own day, who writes in Baconian vein: "The Dryad of old poetry has been recalled to life by modern science. . . . We need to see that we not only enter the storehouses of fact, but seek and keep the keys. . . . We have not to learn dogmas, but to seize the clues.

But, with all its uncritical want of precision, Bacon's own view is no mere summary: it is a real though sometimes shadowy premonition of the later discoveries that have linked together, under the conception of "Correlation of Forces," the polarity of Magnetism, the spark of Electricity, the affinity of Chemical elements and of Crystalline poles, Heat, Light, and picture-rendering rays, as undulations of the universal air. Similar syntheses are embodied in Schelling's Harmonies of Nature, and, in the comprehensive view of Hegel, "Magnetism is the universal act of investing multiplicity with unity;" but they are nowhere clad in such imaginative reality as in Bacon's extension of the world by the revelation of an unseen universe, — a Fairyland of Science, in which we are "citizens of no mean city."

The eras of Comte revolve, but in widening circles, as the positive again merges in the religious. The Greeks followed a mirage of the land they never reached. The forces of Nature address the child in picture and in myth: heaven lies about him, because his fancies do not transcend the dome of blue, and he sees in the twilight the celestial gates: the stars to him are gods, and make a "sphery chime." Later, "the intellectual power,

through words and things, pursues its dim and perilous way" to the same goal, and Nature once more appears as "the garment of divinity." The world is one—"one law, one element," is the first utterance and the last, the Alpha and Omega of philosophy; but, at the close, the fictitious has been exchanged for the real, when Faith, Fancy, and Truth are blended in a higher Metaphysic. These ideas are common to Bacon with other theorists. He stands almost alone in his belief in being able to make them live. He indulged in no Aristotelian θεωρία or Neo-Platonic dream, but gave himself to minister to the wants of mankind at large, which he loved with a philanthropy often inconsistent with personal devotions. He revived the "games in honour of Prometheus—that is, of human nature—that the victory might no longer depend upon the unsteady and wavering torch of each single man, but emulation and good fortune be brought to aid." With him knowledge alone had no satiety: in age, when "the Loves are changed into the Graces," he still ran the race as in the heyday of youth, never feeling the weariness of Faust, and only at times the "suave mari magno." His Philosophy has its concrete presentation in the 'New Atlantis' that rises from the sea, like Prospero's isle, the most practical and among the most poetic of the anticipations of the Future. An allegory of his fragmentary work, it is among torsos the most beautiful; and, in closing the record of his varied life, we linger on the sound of the sea rippling by its richly coloured shore. Its detail may be faulty; its design is prophetic; nor in Plato or Augustine, nor in More or Sidney, in Campanella or Milton, is there so much sympathy with the "increasing purpose" of man's

thought and will. Bacon never soars away from life; he realises its complexity, its temptations, and the indefinite range of its aggregate power. Like Shakespeare, he "puts a girdle round the world;" and he has left a name to be a perennial beacon; for though in a sense one of the "infanti perduti," he has been duly enthroned among the eternal benefactors of his race.

I.

GREEK MEN OF SCIENCE AND PHILOSOPHERS REFERRED TO BY BACON.

Names.		Proximate Dates.
		B.C.
Thales,	Era of Seven Sages,	644-548
Anaximenes,		fl. 548
Pythagoras,		fl. 531
Parmenides,	Eleatic School,	fl. 505
Heraclitus,		fl. 505
Leucippus,	Atomic Theory,	fl. 480
Anaxagoras,		500-428
Democritus of Abdera,	Atomic Theory,	fl. 450
Empedocles of Agrigentum,	Eclectic,	fl. 444
Philolaus,	Pythagorean,	c. 425
Socrates,		468-399
Hippocrates,	Physician,	460-357
Aristippus,	Cyrenaic,	400-365
Plato,		429-347
Diogenes, the Cynic,		419-324
Eudoxus,	Mathematician,	fl. 360
Aristotle,		384-322
Pyrrho,	Sceptic,	fl. 350
Zeno of Citium,	Stoic,	362-264
Epicurus,	Epicurean and Atomist,	341-270
Archimedes,		287-212
Carneades of Cyrene,	New Academy,	213-129
Hipparchus,	Astronomer,	fl. 160
Cicero,	Eclectic,	106-43
Lucretius,	Atomist and Epicurean,	99-55
Celsus,	Physician,	A.D. fl. 17

Names.	Proximate Dates.
Philo Judæus,	B.C. 20- ?
Apollonius of Tyana,	B.C. 4- ?
	A.D.
L. Annæus Seneca,	3-65
Pliny, major,	23-79
Pliny, minor,	61-105
Plutarch,	40-120
Epictetus, Stoic,	fl. 117-138
Ptolemy, Astronomer,	139-161
Lucian, Sceptic,	120-200
Galen, Physician,	130-200
Sextus Empiricus, Sceptic,	fl. 225
Julian,	reigned 361-363
Proclus,	412-485

II.

LIST OF BACON'S MOST EMINENT PREDECESSORS AND CONTEMPORARIES.

(Those marked with an asterisk are referred to or quoted by Bacon, though not always by name.)

Names.		Proximate Dates. A.D.
Geber,	Alchemist,	d. 777
Alcuin,		735-804
Khalif Jaafar al Mansur,		754-775
J. Scotus Erigena,		d. 875
Albategni,	Astronomer,	850-925
*Rhazes,	Chemist and Physician,	860-940
Alfarabi,	Astronomer,	d. 950
Aboul-Wefa,	Astronomer,	fl. 975
Gerbert (Silvester II.);		940-1003
*Avicenna (Ibn Sina),	Arab Aristotelian,	978-1037
Alhazen,	Astronomer and Optician,	d. 1038
Anselm,		fl. 1093-1109
Roscelin,		d. 1106
Algazel,		1058-1111
Abelard,		1079-1142
Peter Lombard,	Schoolman,	d. 1164
John of Salisbury,	Attacks Schoolmen,	1110-80
*Averroès (Ibn Roschid),	Arab Aristotelian,	1120-98
Vincent of Beauvais,	'Speculum Mundi,'	c. 1190-1264
Albertus Magnus,	Schoolman,	1193-1280
Michael the Scot,	Physicist and Magician,	?1200-70
*Roger Bacon,	Physicist,	1214-92
Alphonso of Castile,	'Alphonsine Tables,'	1221-84
*Thomas Aquinas,	Schoolman,	1227-74
*Duns Scotus,	Schoolman,	1265-1308
*Raymond Lully,	Logician and Mystic,	1235-1315
*Arnold of Villanova,	Physician and Alchemist,	1235-1315
William Occam,	Logician,	1300-47

Names.		Proximate Dates.
*Pedro de Alliaco,	'Imago Mundi,'	fl. 1410
Nicholas of Cusa,	Heliocentric Theory,	1401-54
Laurentius Valla,	Attacks Aristotle,	1407-57
*L. Costar and J. Guttenberg,	Invention of Printing,	fl. 1438-45
J. Muller (Regiomontanus),		1436-76
Pico della Mirandola,		1463-94
*Marsilius Ficinus,	Italian Platonist,	1433-99
Pietro Pomponazzi,		1462-1526
Bartholomew Glanvill,	Properties of Things,'	fl. 1478
*Columbus,	America discovered, 1492,	1435-1506
*Philippe de Comines,		1445-1511
Leonardo da Vinci,		1452-1519
*Erasmus,		1467-1536
*Cornelius Agrippa,	'De incertitudine et vanitate scientiarum,'	1486-1535
*Machiavelli,		1469-1527
*Guicciardini,		1482-1540
*Copernicus,		1473-1543
*H. Fracastorius,	Physician of Verona,	1483-1553
*Paracelsus,	Chemist and Alchemist,	1493-1541
*Polidore Vergil,	Compiler,	c. 1470-1555
*George Agricola,	Metallurgist, &c.,	1494-1555
Ludovicus Vives,	Attacks Aristotle,	1498-1540
*Melanchthon,	Reformer and Aristotelian,	1497-1560
F. Maurolycus of Messina,	Optician,	1494-1575
*F. Chrysogonus,	Work on "Tides,"	fl. 1527
*J. F. Fernelius,	Ast. and Physician to Henry VIII.,	c. 1500-58
J. Acontio,		1492-1566
Conrad Gesner,	'Bibliotheca Universalis,'	c. 1516-65
*J. Cardan,	Mathematician,	1501-76
Leonard Fuchs,	Botanist and reviver of Galenism,	1501-66
A. Vesalius,	First scientific Anatomist,	1514-64
G. Mercator,	Geographer,	1512-94

Names.		Proximate Dates.
*Telesio of Cosenza,	'De Naturâ Rerum,' 1565,	1509-88
*Peter Ramus,	Logician,	1515-72
*A. Cesalpinus,	Botanist,	1519-1603
Levinus Lemnius,	'De Miraculis Naturæ,'	fl. 1559-64
J. B. Benedetti,	Physicist,	1530-90
*F. Patricius,	'Nova Philosophia,'	1529-97
G. Fabricius (Aquapendente),	Physician,	1537-1619
*Montaigne,		1533-92
*Francis Vieta,	Mathematician,	1540-1603
*Giambattista Porta,	'Magna Naturalis,'	c. 1540-1615
*Joseph d'Acosta,	'Voyage to the Indies,'	1540-99
*Petrus Severinus	'Idea Medicinæ Philosophicæ,'	1542-1602
*Tycho Brahe,	Astronomer,	1546-1601
*Giordano Bruno,		1580-1600
*Otto Casmann,	'On Tides,'	fl. 1596
*William Gilbert,	Magnetism,	1540-1603
John Napier,	Logarithms (1614),	1550-1617
*T. Harriot,	Math. and Ast.,	1560-1621
*M. Ghetaldus,	Hydrostatist,	1566-1627
*Simon Stevinus,	Math. and Mechanician,	? -1633
*Robert Fludd,	Physicist and Mystic,	1574-1637
Jacob Bœhmen,	Mystic,	1575-1624
*Galileo,	Astronomer, &c.,	1564-1642
Kepler,	Astronomer,	1571-1630
*T. Campanella,	Platonist, &c.	1568-1639
Van Helmont,	Chemist,	1577-1644
William Harvey,	Circulation of the blood (1619),	1578-1656
René Descartes,		1596-1650

III.

CHRONOLOGICAL LIST OF BACON'S CHIEF WORKS.

B. = Bacon.
R. (1) = Rawley. First collection, 1627.
R. (2) = Rawley. Second collection, 1657. 'Resuscitatio' of Sleeping Pieces.
G. = Gruter. Impetus Philosophici, 1653.
S. = Stephens. 1734.
Sp. = Spedding. 1857.
T. = Tenison. 1679.

* Those to which an asterisk is appended, and other State or political papers, were circulated, rather than published, shortly after their composition.

Titles.	Dates of Writing.	Dates of Publication.
Letter of Advice to Queen Elizabeth, *Æt.* 24,	1584	*
Temporis Partus Maximus, . . *Æt.* 25,	1585	
On the Controversies of the Church, *Æt.* 29,	1589	*
Conference of Pleasure. Masque for Essex, Praises of Fortitude, of Love, of the Queen, of Knowledge,	1593	
Promus of Formularies and Elegancies, . .	1595	Sp. 1859
Observations on a Libel, ...	1593	*
Contributions to 'Gesta Grayorum.' Speeches of Counsellors, and suggestion of Palace of Learning,	1594	
First Edition of Essays (10), with "Colours of Good and Evil" and Meditationes Sacræ,	(?)	B. 1597
Declaration of Treasons of Essex, . . .	1601	*
Confession of Faith, ... *ante*	1603	
Cogitationes de Rerum Naturâ, . . .	1600-4	G. 1653
Cogitationes de Scientiâ Humanâ, . . .		Sp. 1857
De Interpretatione Naturæ Proœmium, . .	1603-5	G. 1653
Discourses on the Union, ...	1603-4	*
Considerations. Pacification of the Church, .	1603	*
Advancement of Learning. Book I., . .	1603	B. 1605

Titles.	Dates of Writing.	Dates of Publication.
Valerius Terminus (View of Form, as "freeing a direction"),	1603 (?)	S. 1734
Apology concerning the Earl of Essex,	1604	*
Advancement of Learning. Book II., Idola,	1605	B. 1605
1st Filum Labyrinthi. Formula Inquisitiones,	1606-7	S. 1734
Delineatio et Argumentum, with first intimation of scheme of Instauratio Magna,	1606-7	G. 1653
Cogitata et Visa,	1607	G. 1653
In Felicem Memoriam Elizabethæ,	1608	*
2d Filum Labyrinthi. Inquisitio de Motu,	1608	G. 1653
Commentarius Solutus,	1608	Sp. 1859
Calor et Frigus,	1608 (?)	S. 1734
Historia Soni et Auditus,	*post* 1608	R. (2) 1657
Temporis Partus Masculus,	1609	G. 1653
Redargutio Philosophiarum,		G. 1653
De Sapientiâ Veterum,	1609	B. 1609
Beginning of History of Great Britain,	1610	
1st Phenomena Universi,	1608-20	G. 1653
Descriptio Globi Intellectualis,	1612	G. 1653
Thema Cœli,		G. 1653
Second Edition of Essays (38),	1607-12	B. 1612
New Atlantis (according to Gardiner),	1614-17	R. (1) 1627
De Fluxu et Refluxu Maris,	*ante* 1616	G. 1653
De Interpretatione Naturæ Sententiæ xii.,	1610-20	G. 1653
Aphorismi et Consilia de Auxiliis Mentis,	*ante* 1620	G. 1653
First Letter of Advice to Villiers,	1616	
Second Letter of Advice to Villiers,	1618 (?)	*
Declaration on Sir Walter Raleigh,	1618	*
Novum Organum, Descriptio Operis, and Parasceve and Catalogues,	1608-20	B. 1620
2d Phenomena Universi, or—		
Historia Naturalis, dedicated to Prince Charles,	1622	B. 1622
Historia Ventorum, Aditus, and Fragment of Abecedarium,		T. 1679
History of Henry VII.,	1621-22	B. 1622
Dialogue on a Holy War,	1622	*
Beginning of Henry VIII.,	1623	
Historia Vitæ et Mortis,	1623	B. 1623
De Augmentis,	1622-23	1623
Historia Densi et Rari. De Magnete,	1623-24	R. (2) 1657
De Luce et Lumine,		G. 1653

Titles.	Dates of Writing.	Dates of Publication.
3d Filum Labyrinthi. Scala Intellectus and Prodromi. Prefaces to Parts iv. and v. of Instauratio,	1624-25 (?)	G. 1653
De Principiis atque Originibus, . .	*post* 1620	G. 1653
New Atlantis (Rawley and Spedding), . .	1624	R (1) 1627
Apophthegms, new and old, and translations of Psalms,	1624	B. 1625
Third Edition of Essays (58), ...	1612-24	B. 1625
Sylva Sylvarum, ...	1624-26	R. (1) 1627
Miscellanies and Historical Fragments. Prayers, &c.,	1600-26	
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